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Myoung et al.

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(54) **CONDITIONER FOR POLISHING PAD AND METHOD FOR MANUFACTURING THE SAME**

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(73) Assignee: **Hunatech Co., Ltd.** (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

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Related U.S. Application Data

(63) Continuation-in-part of application No. 09/521,035, filed on Mar. 8, 2000, now Pat. No. 6,439,986.

(30) **Foreign Application Priority Data**

Oct. 12, 1999 (KR) 1999-21946
Feb. 15, 2000 (KR) 2000-7082

(51) **Int. Cl.**^{7} **B24D 18/00**

(52) **U.S. Cl.** **51/293**; 51/295; 51/298; 451/443; 451/548

(58) **Field of Search** 51/307, 295, 297, 51/298, 293; 451/443, 527, 539, 548; 428/195, 323, 141, 134

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(57) **ABSTRACT**

A conditioner for polishing pad and a method for manufacturing the same are disclosed. The conditioner comprises a substrate having formed with a plurality of geometrical protrusions of an uniformed height on at least one of its sides, and a cutting portion having a diamond layer of an uniformed thickness formed substantially on a whole surface of the side of the substrate having the geometrical protrusions. The geometrical protrusions have a flat upper surface or the upper surface may comprise a plurality of smaller geometrical protrusions formed by recessed grooves. The substrate is made from ceramic or cemented carbide materials and has a shape of a disk, a plate having multiple corner, a cup, a segment, or a doughnut with flattened upper and lower surfaces. The conditioner may further comprise a body portion being fixedly attached to the substrate at a side opposite to the side having formed with geometrical protrusions for linking the cutting portion to conditioning equipment. The cutting portion of the conditioner realized by having above shapes and structures makes line and surface contacts with polishing pad surface. The diamond layer coated on the cutting surface strengthens the structural integrity of the cutting surface to increase the cutting performance and imparts anti-wear and anti-corrosive properties to render the conditioner with a prolonged lifetime usage.

17 Claims, 25 Drawing Sheets

FIG. 1A
(PRIOR ART)

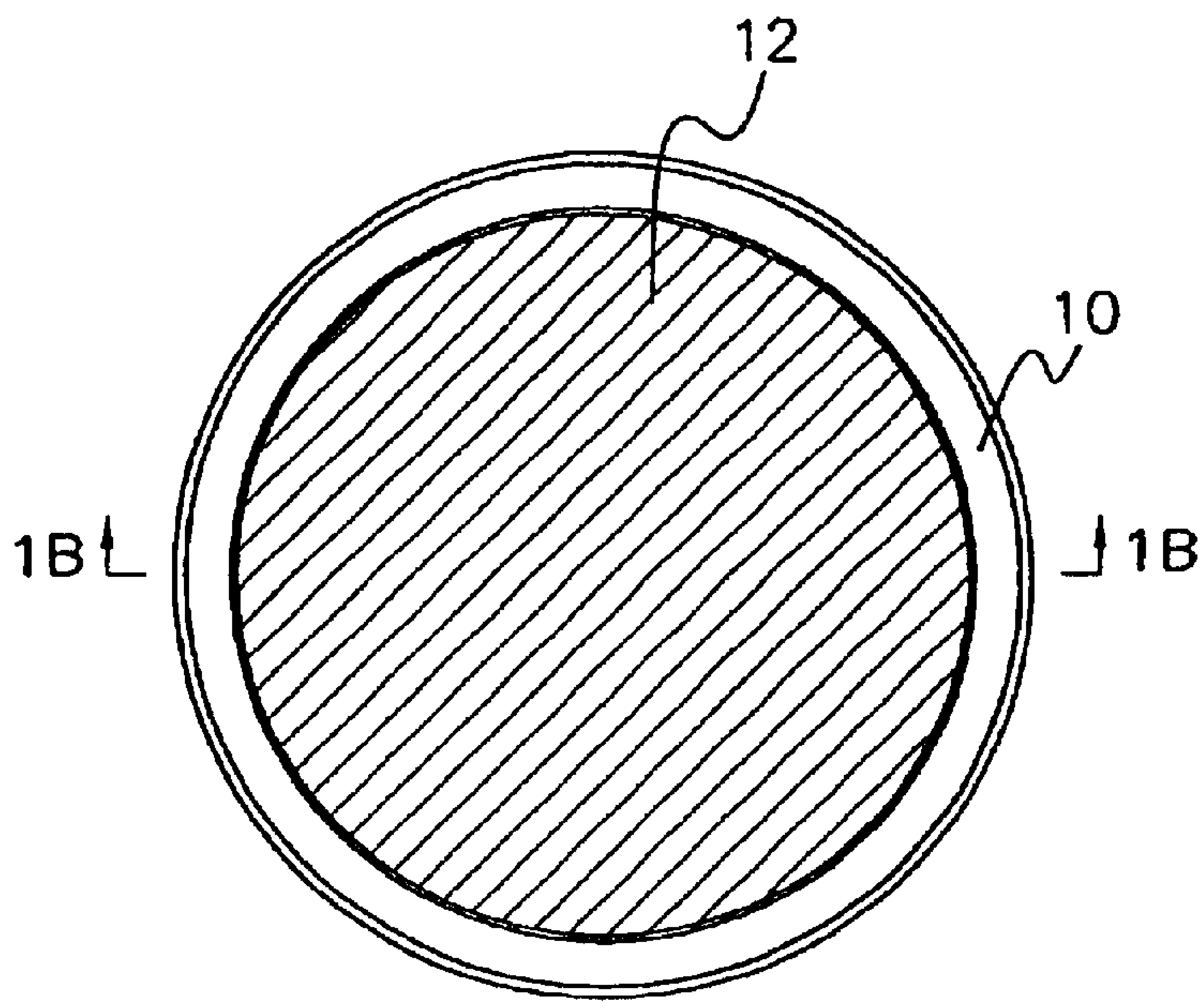


FIG. 1B
(PRIOR ART)

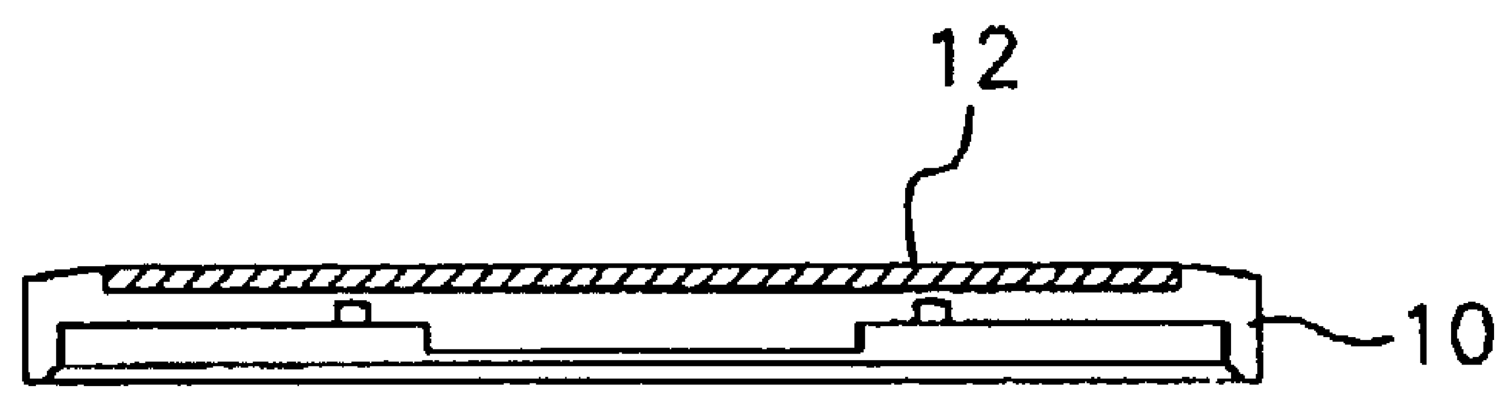


FIG. 1C
(PRIOR ART)

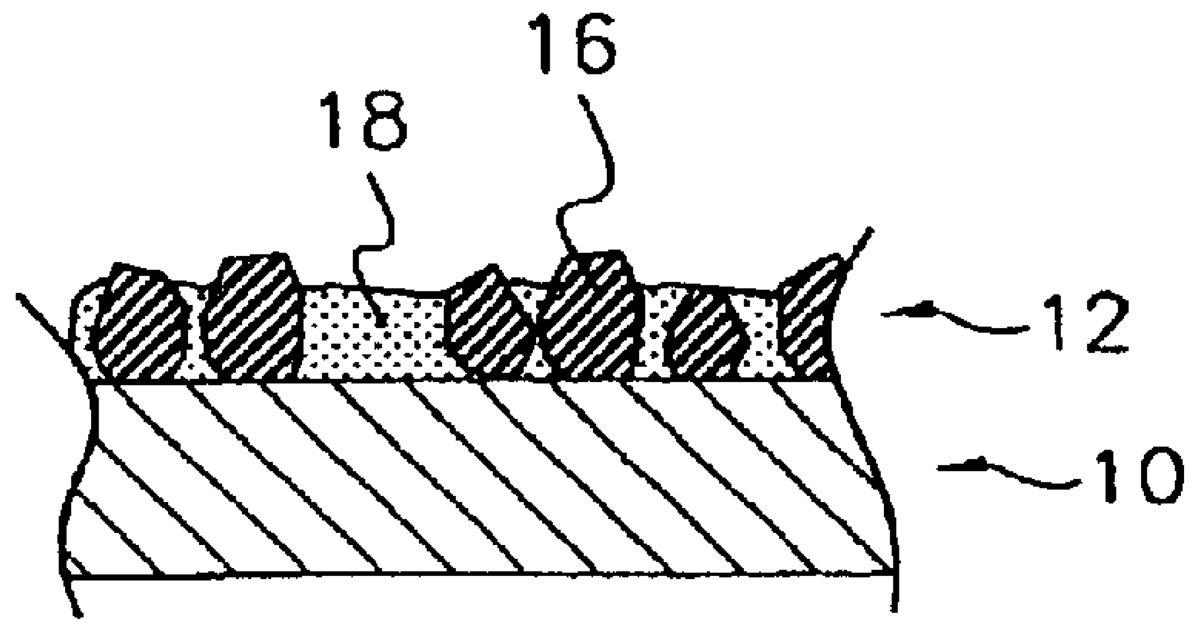


FIG. 2A

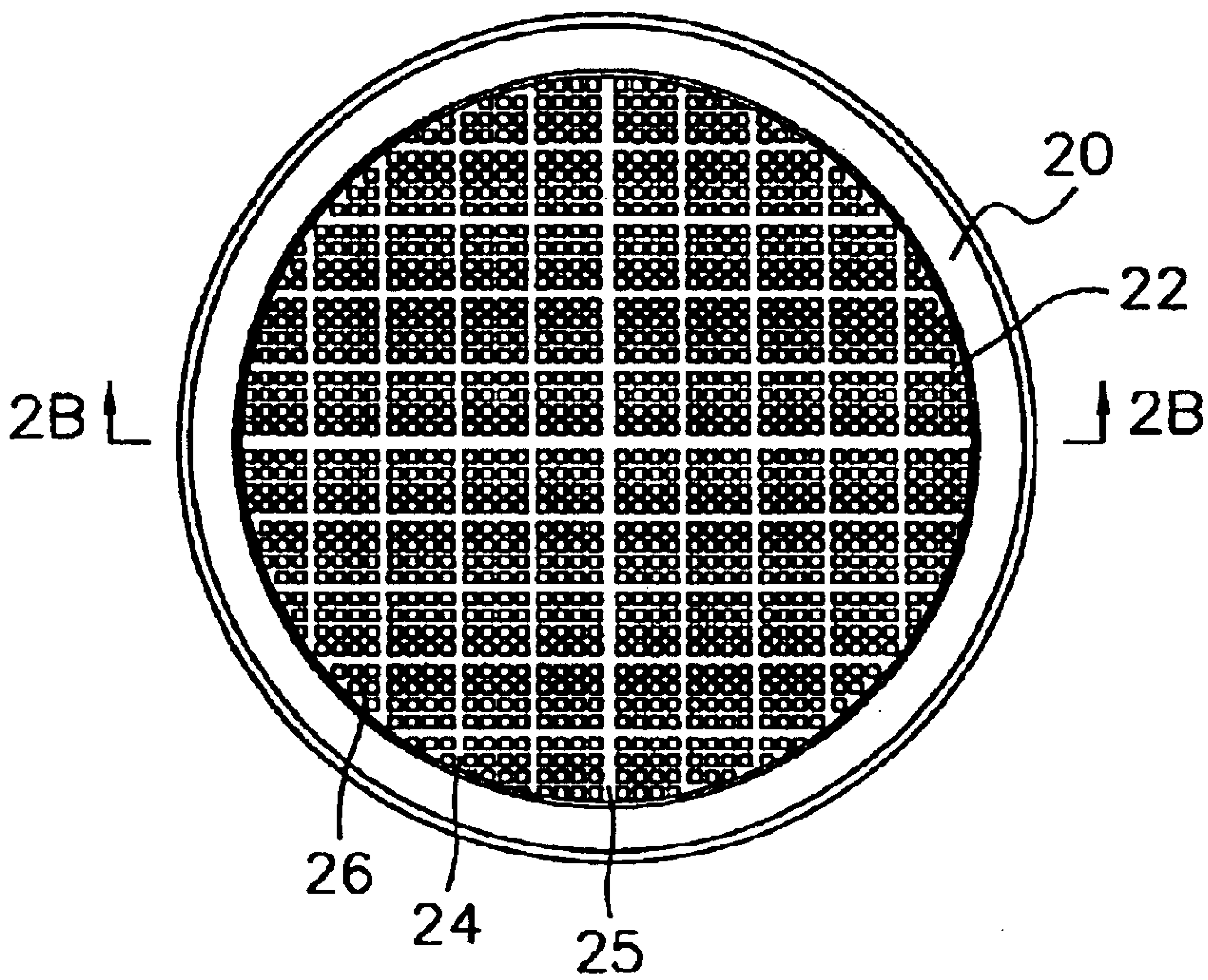


FIG. 2B

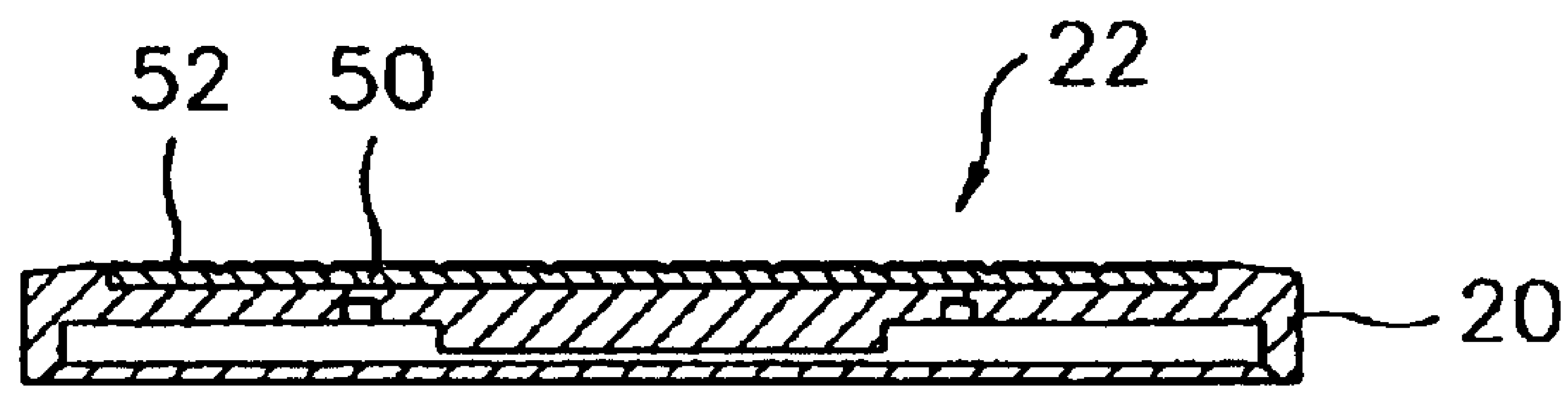


FIG. 2C

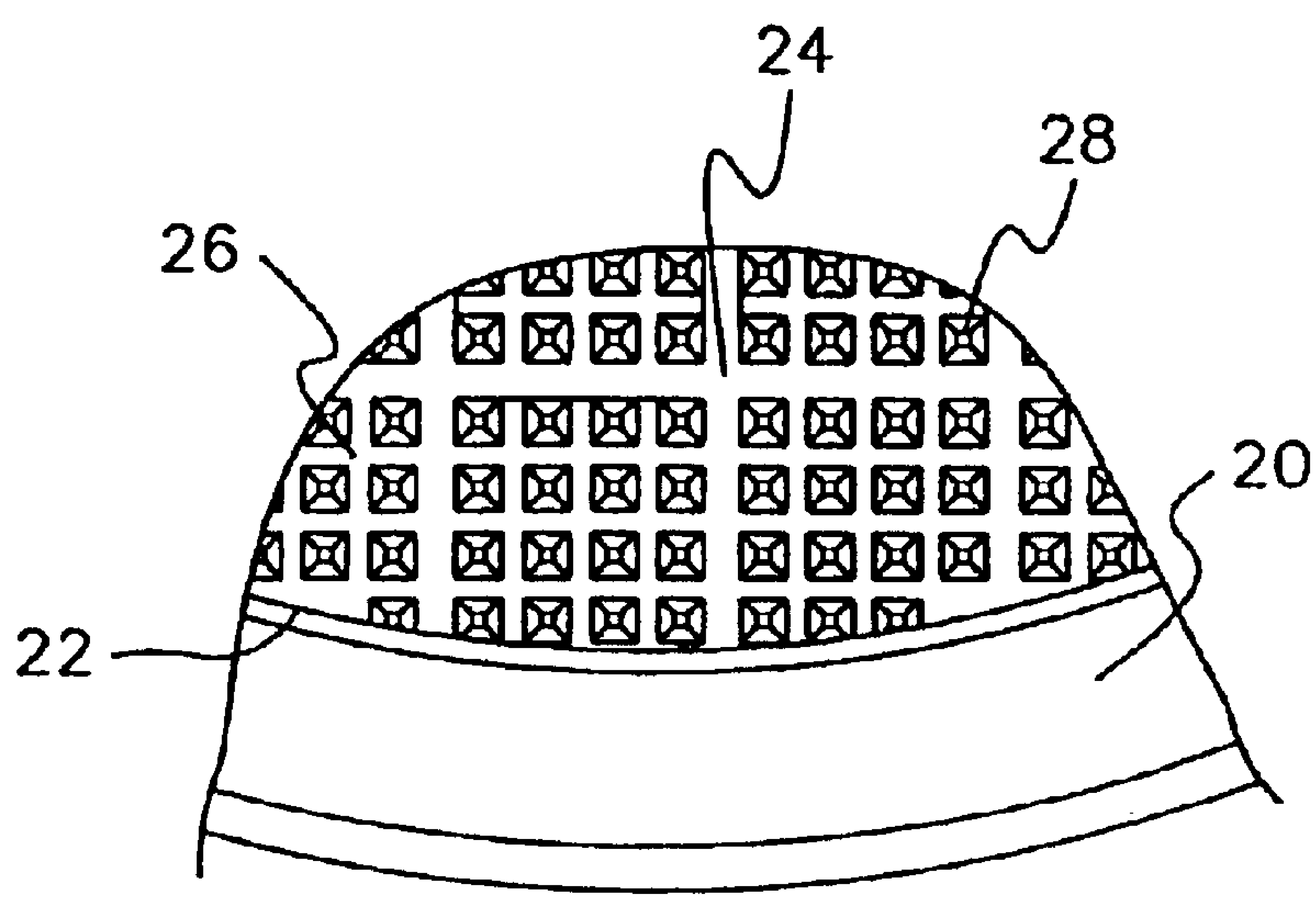


FIG. 2D

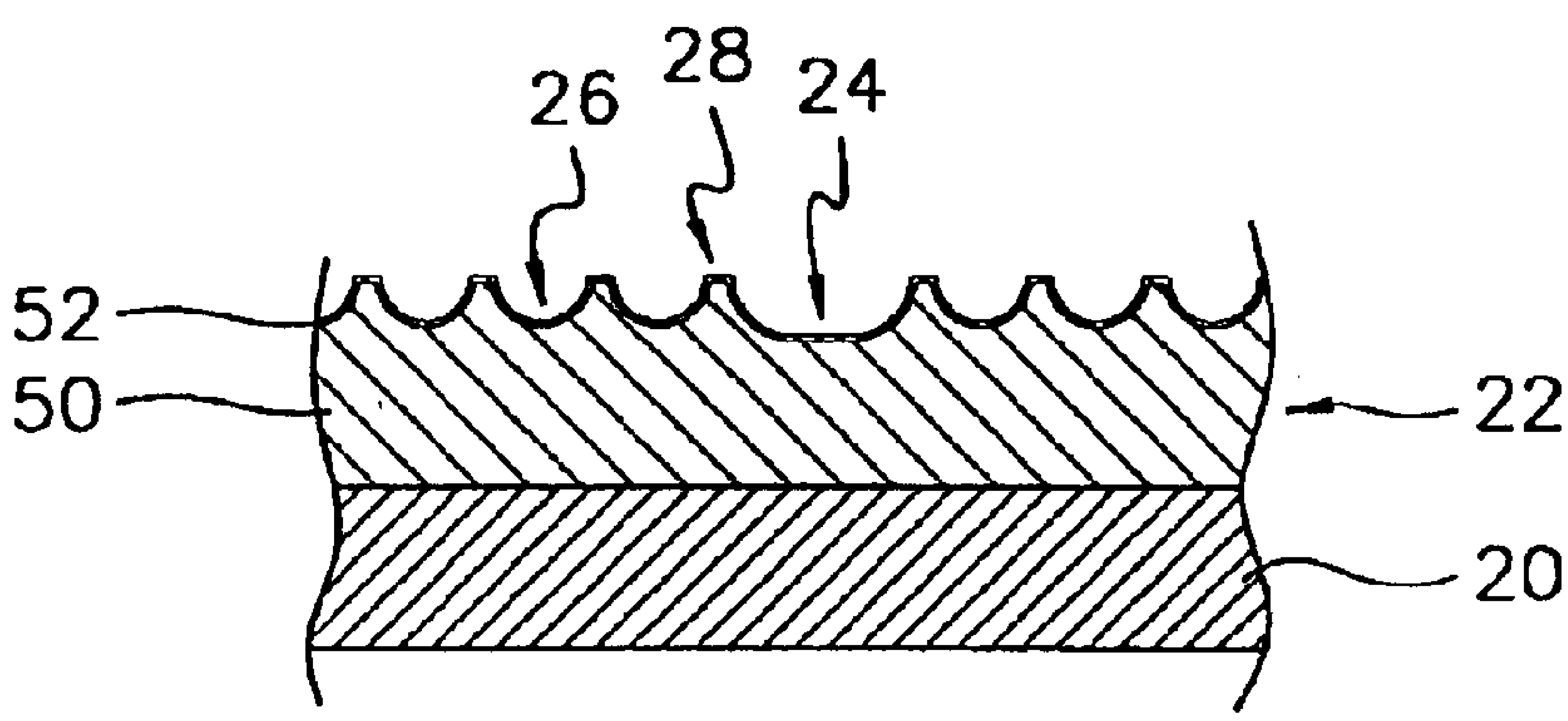


FIG. 2E

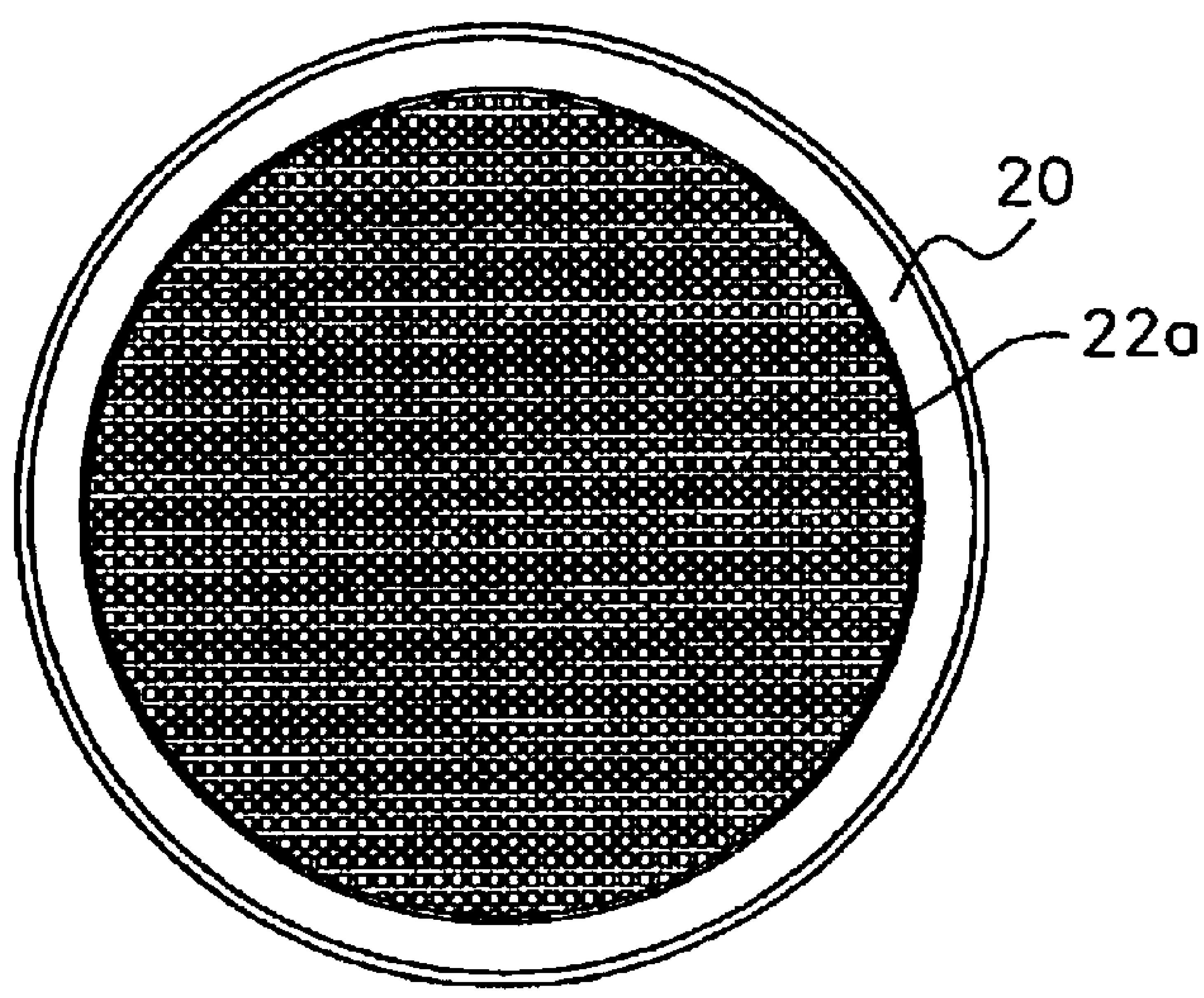


FIG. 2F

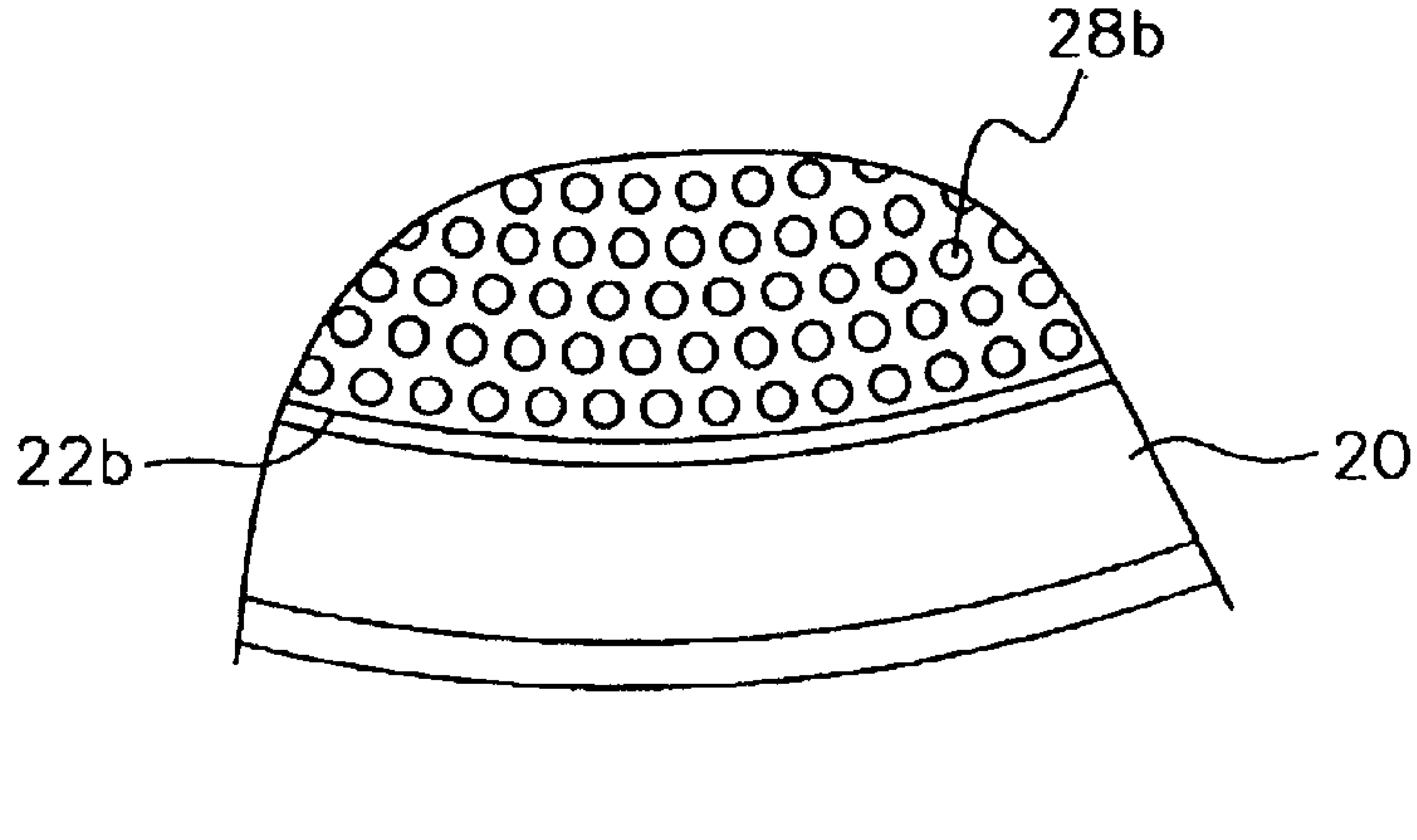


FIG. 3A

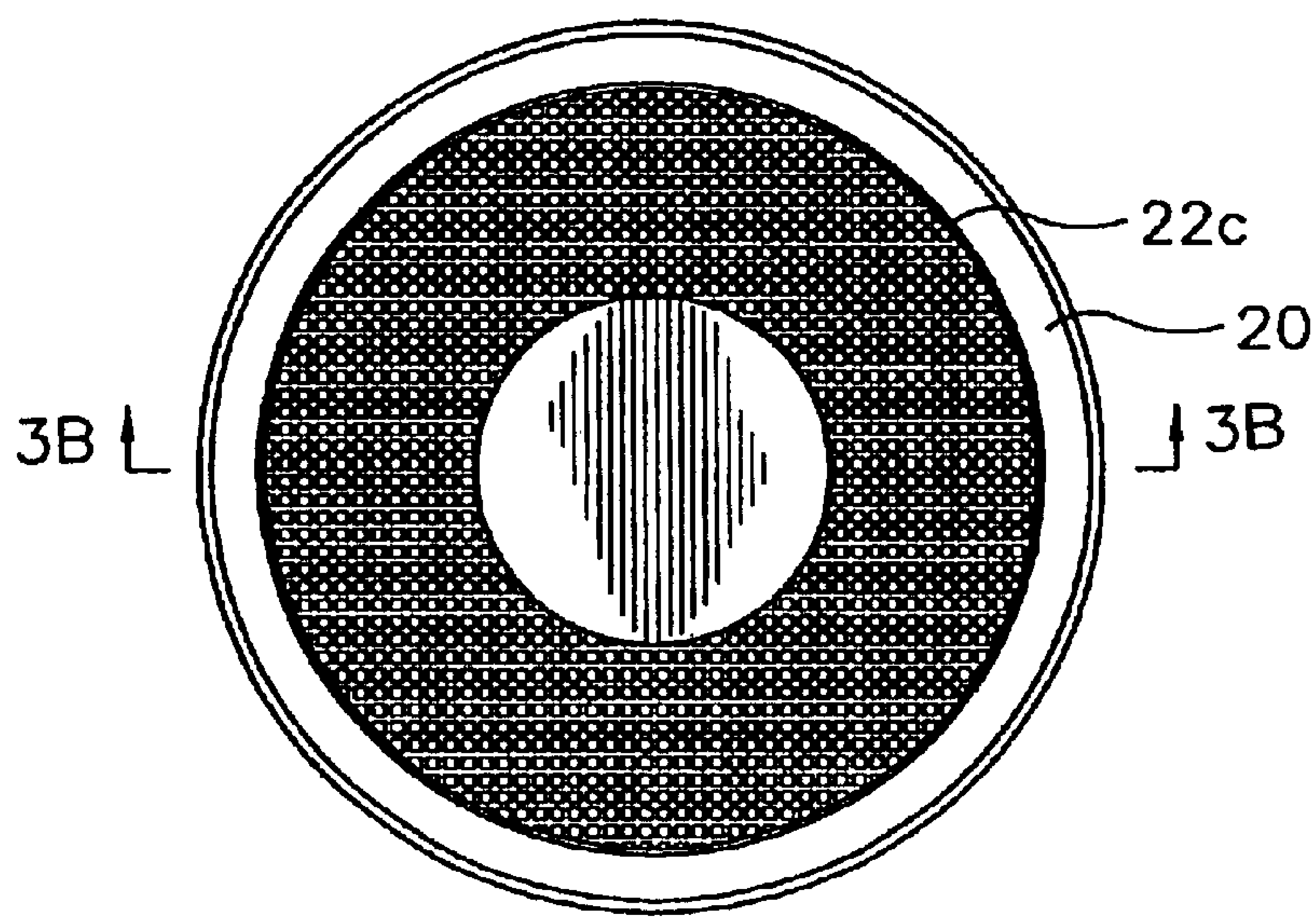


FIG. 3B

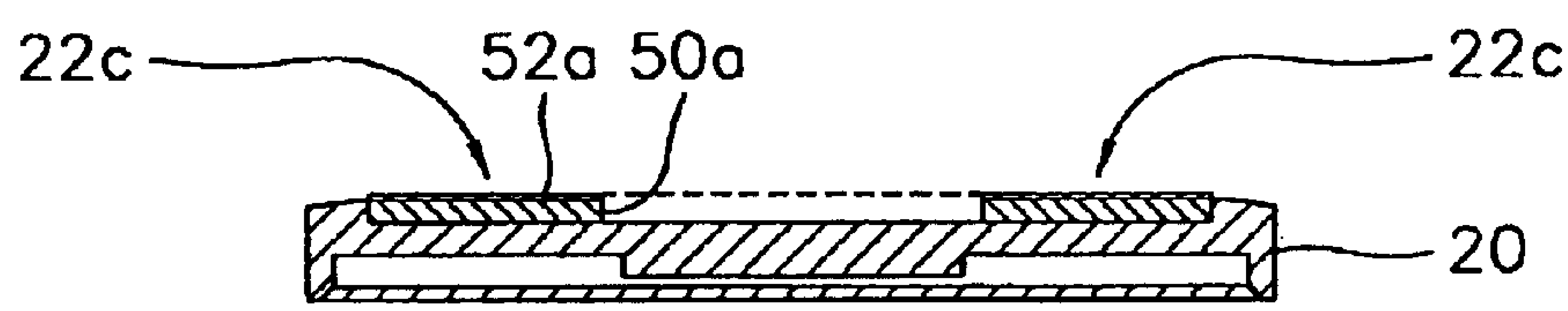


FIG. 4A

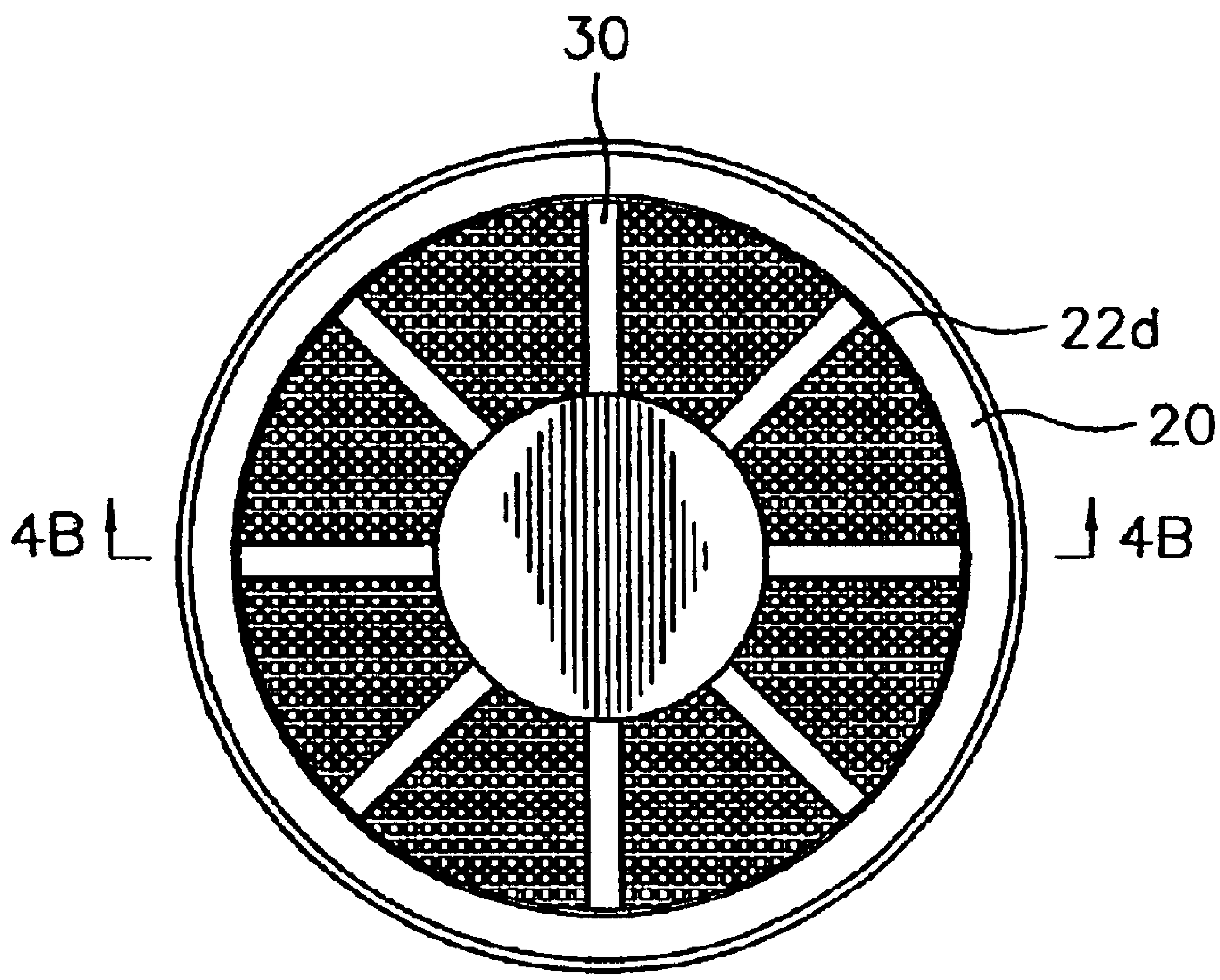


FIG. 4B

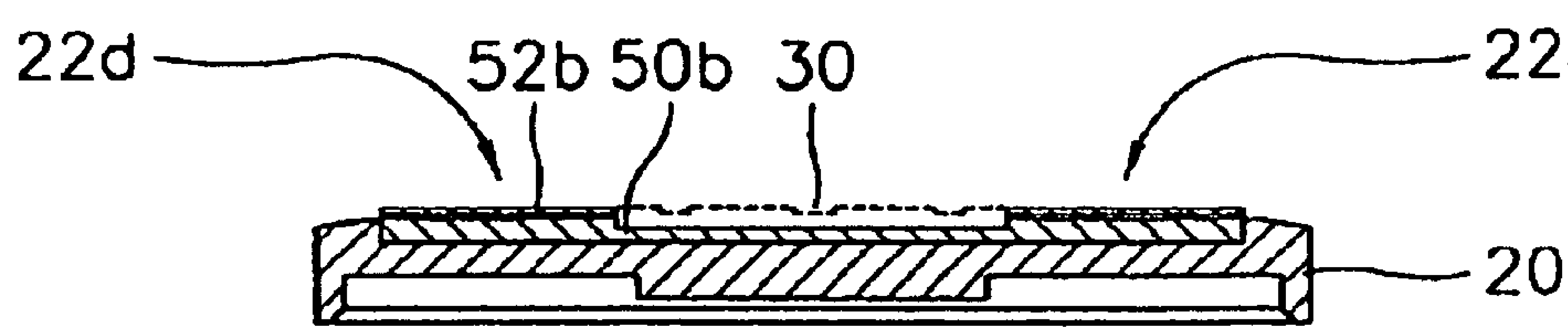


FIG. 5A

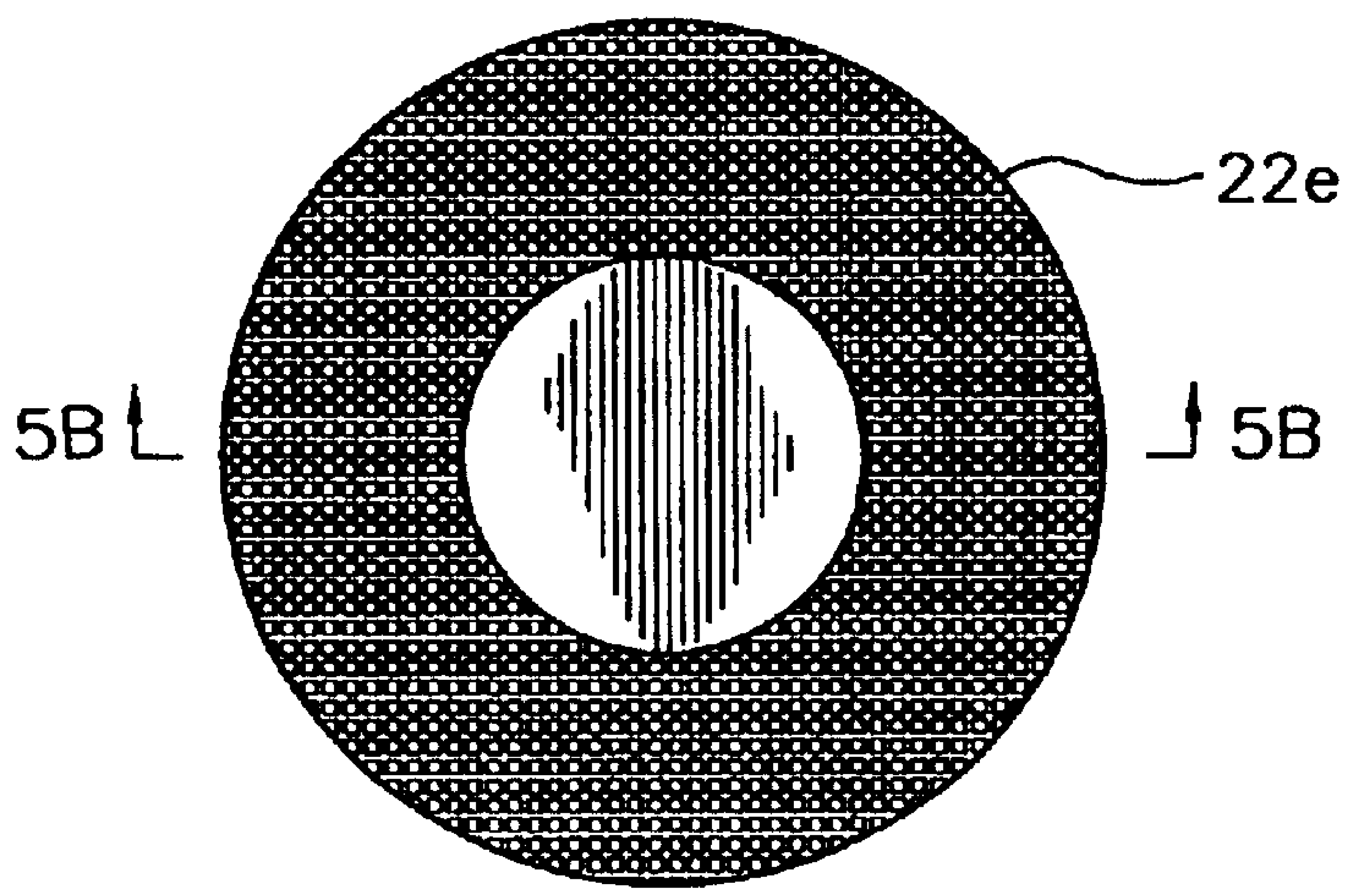


FIG. 5B

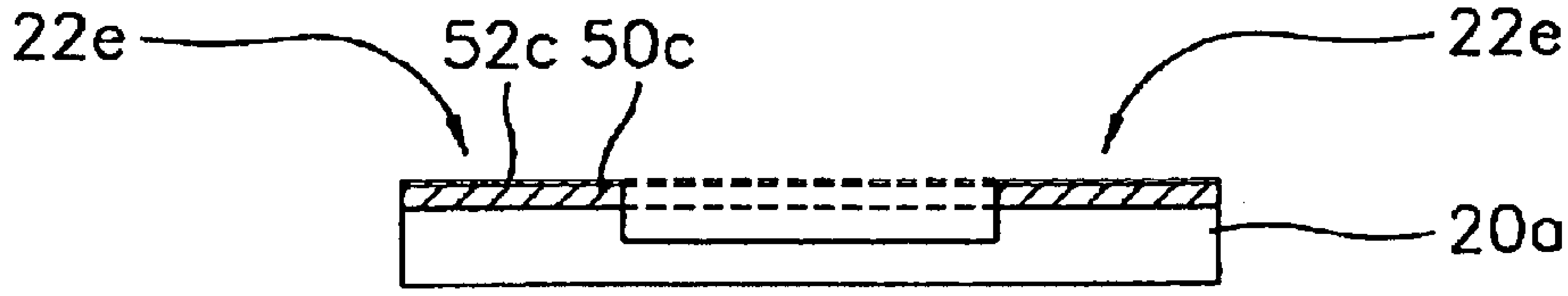


FIG. 6A

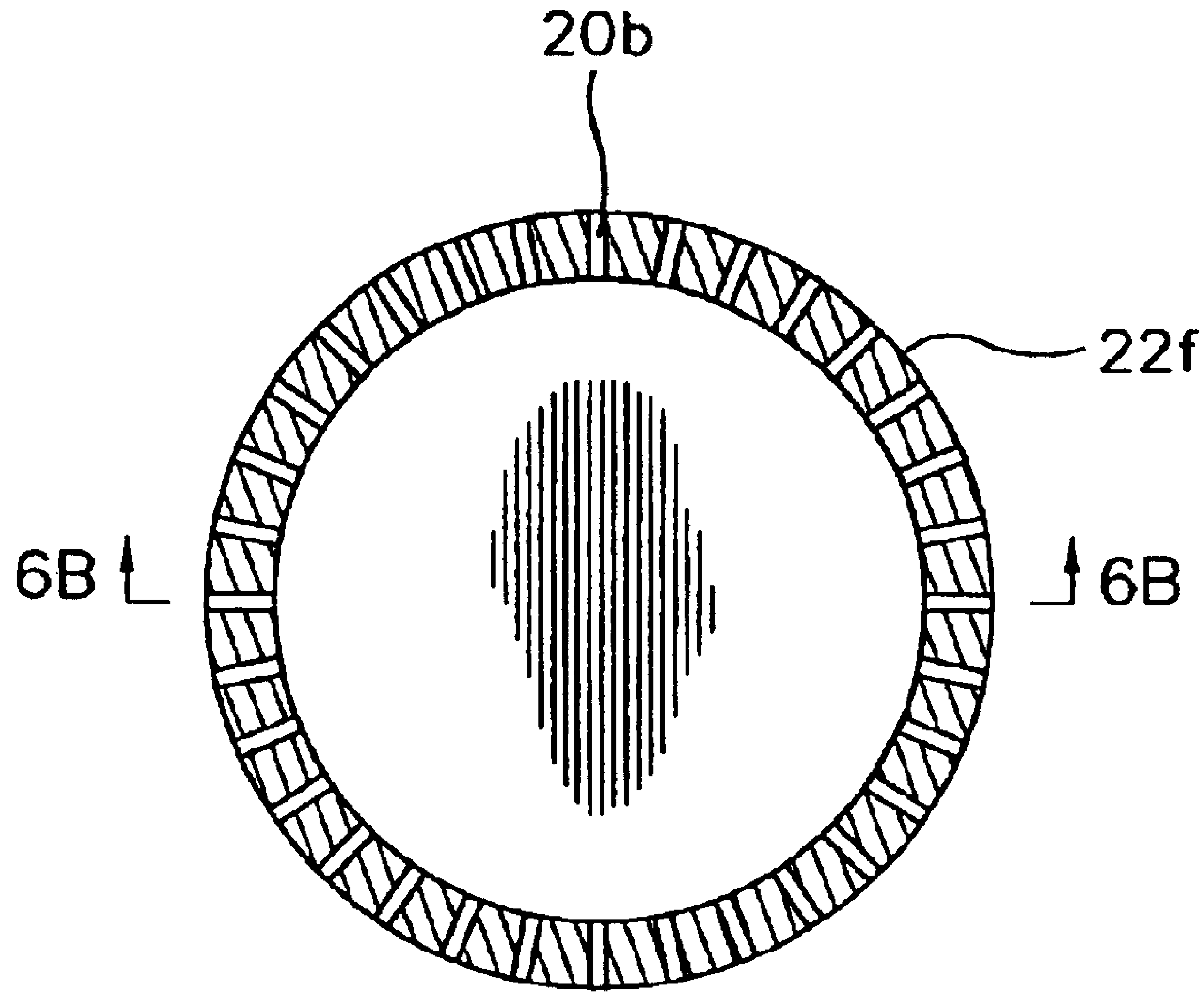


FIG. 6B

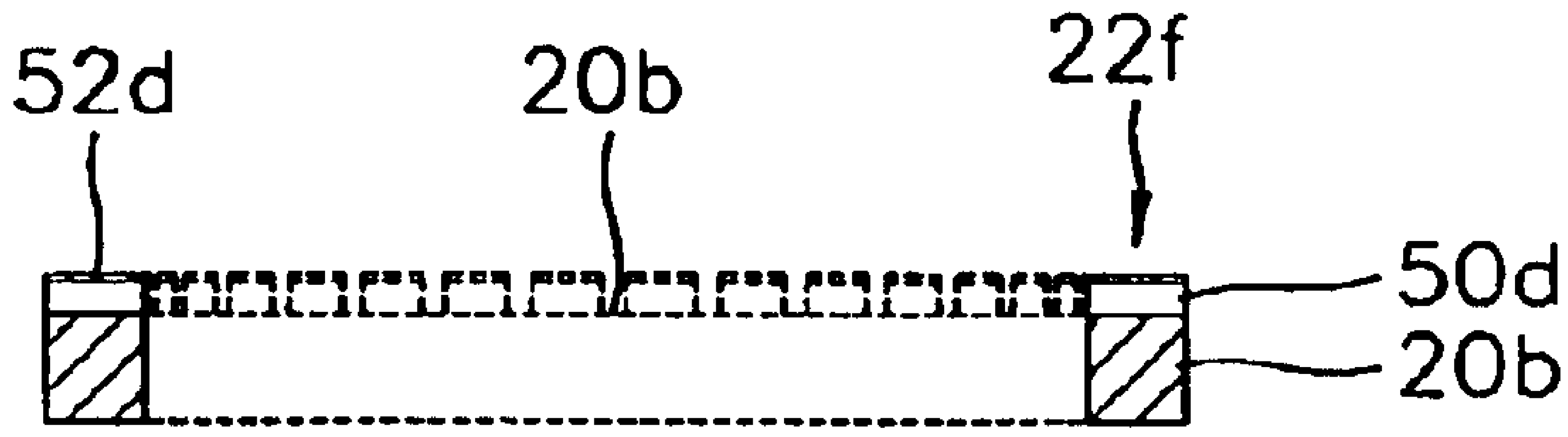


FIG. 7A

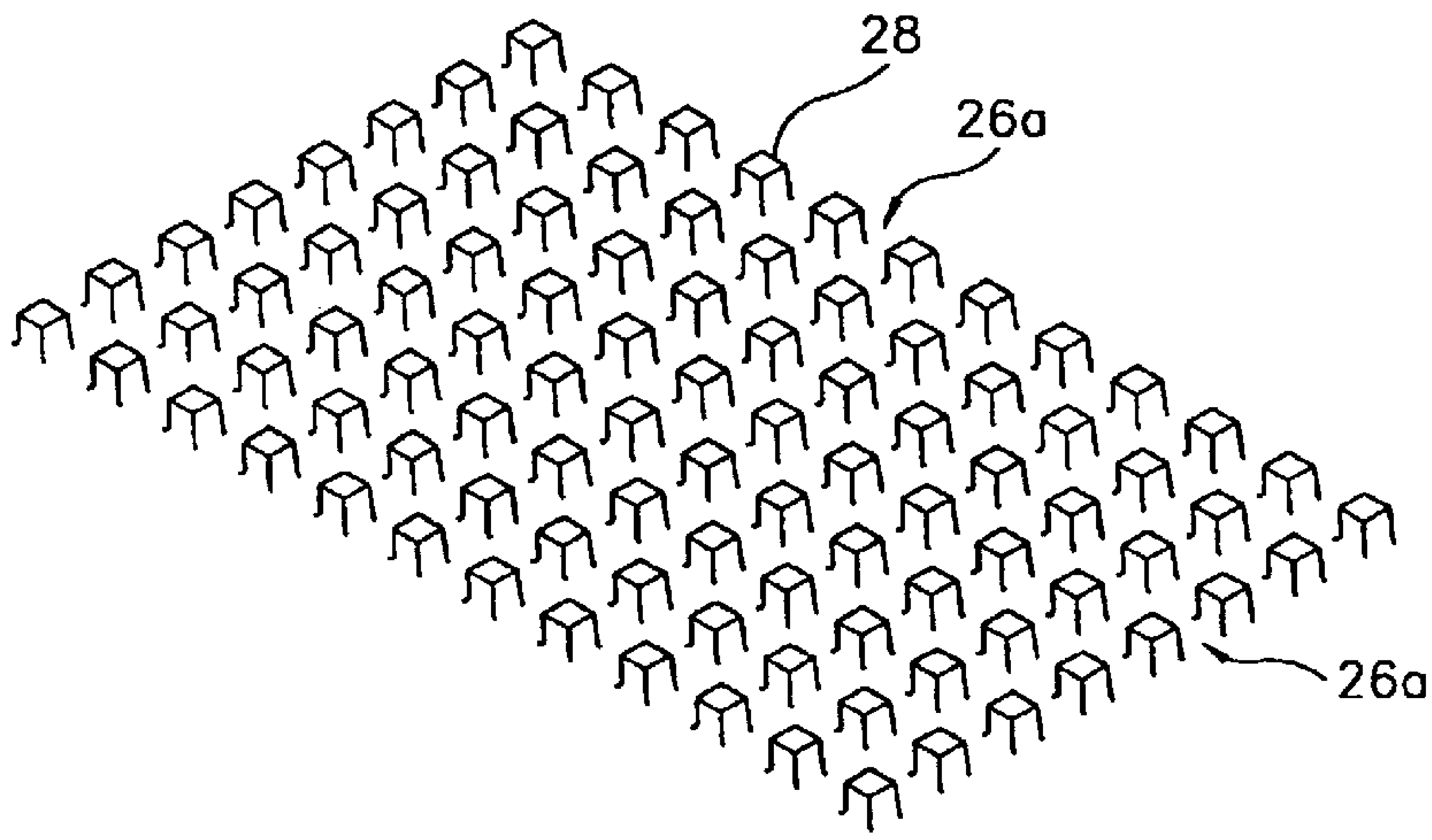


FIG. 7B

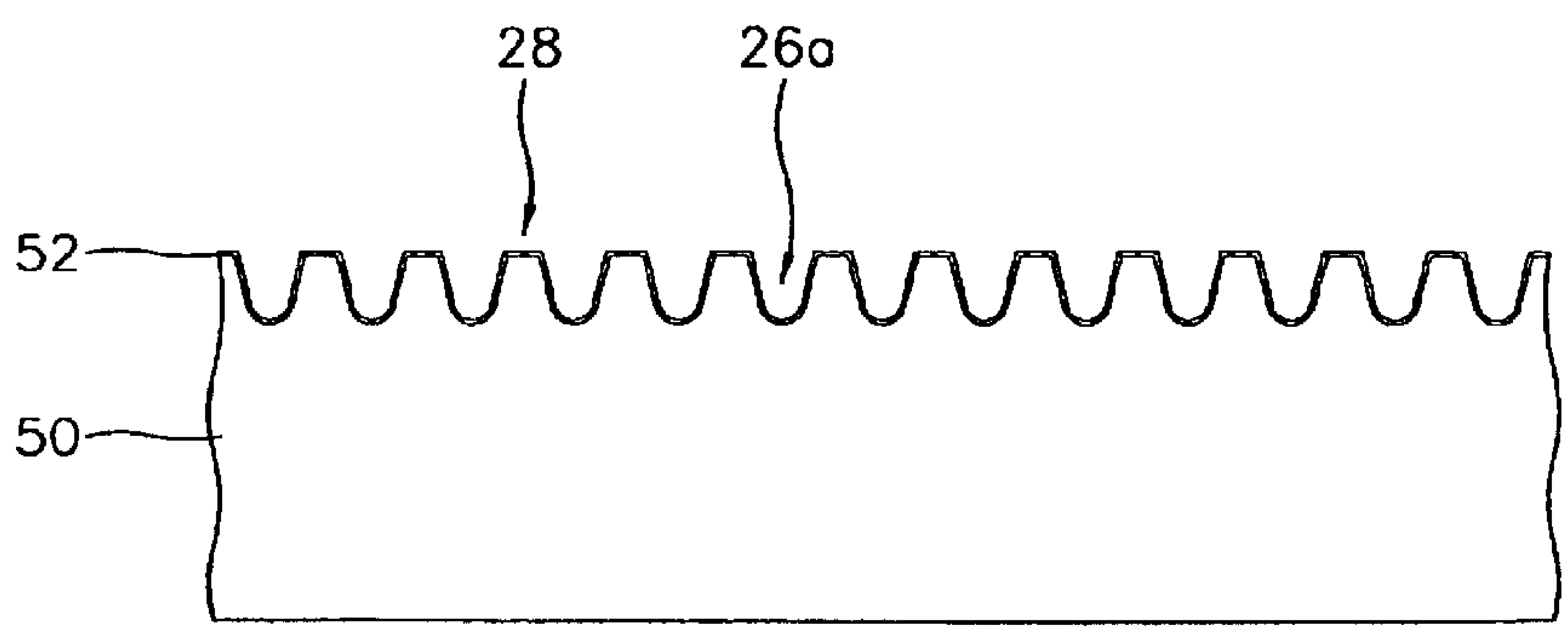


FIG. 8A

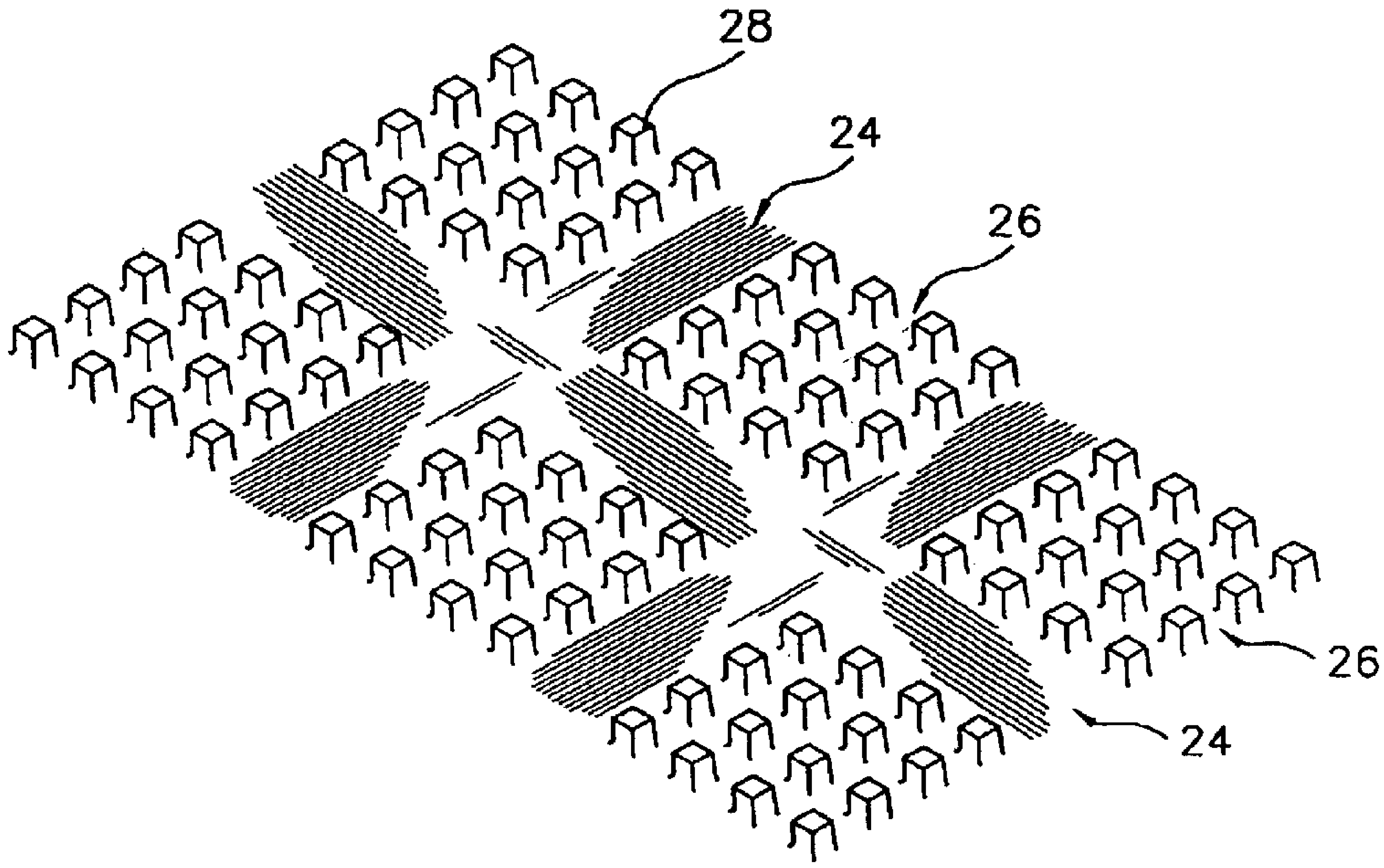


FIG. 8B

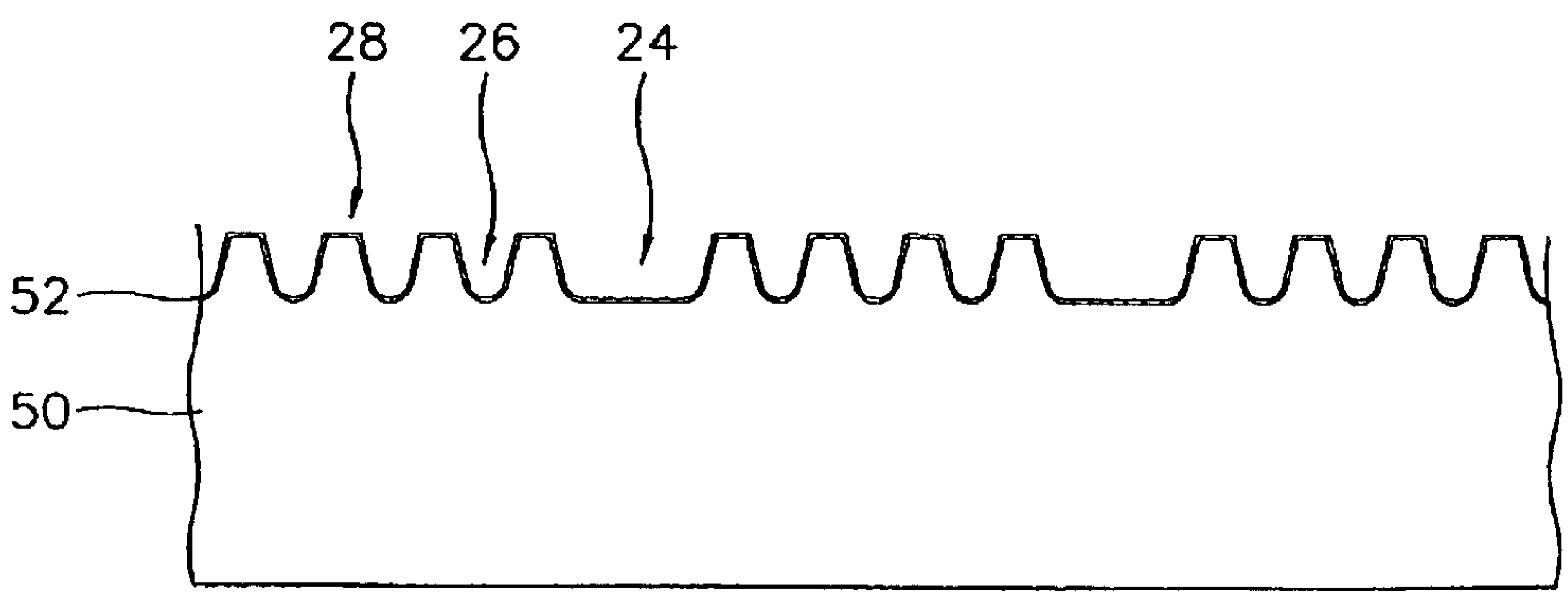


FIG. 9A

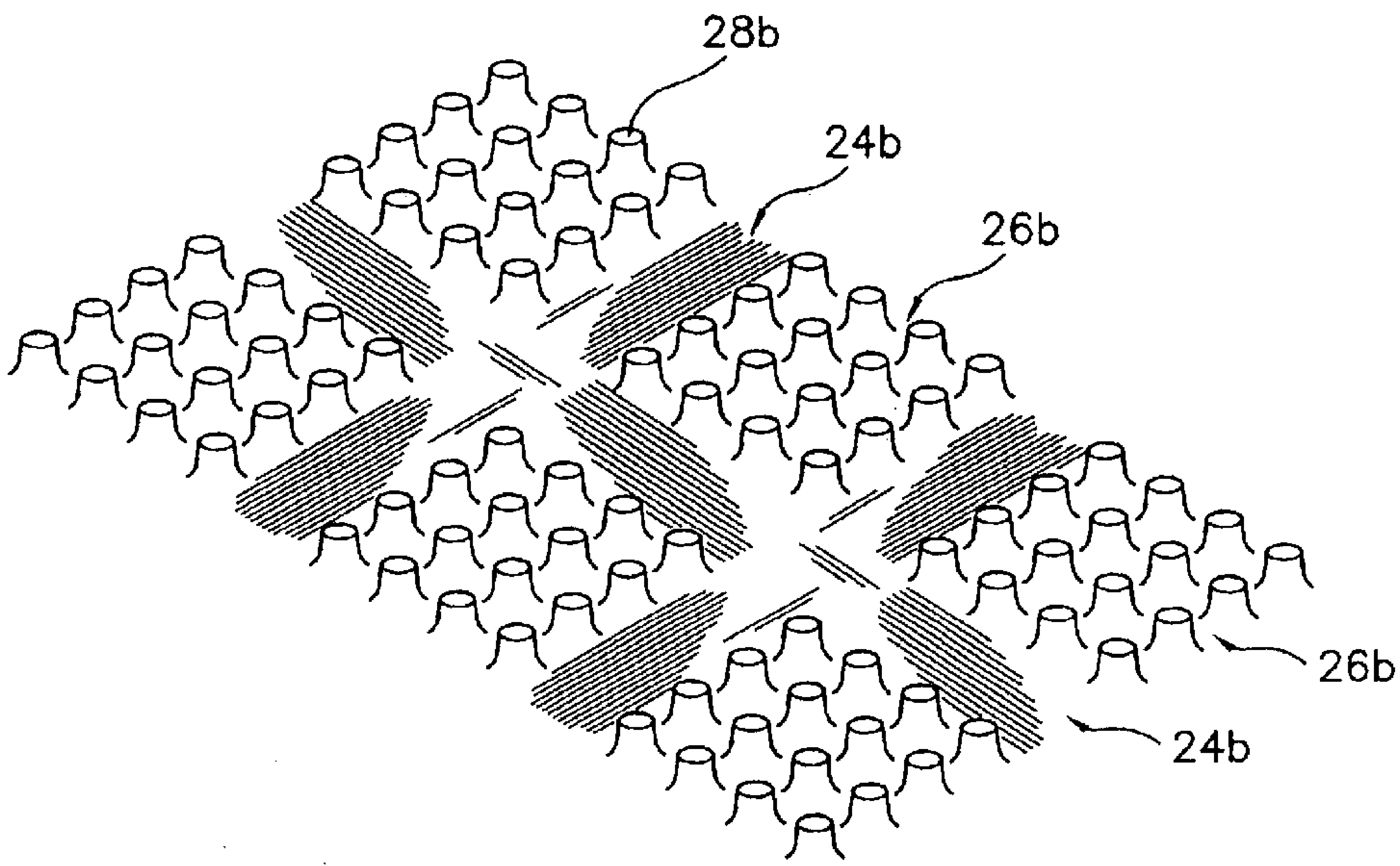


FIG. 9B

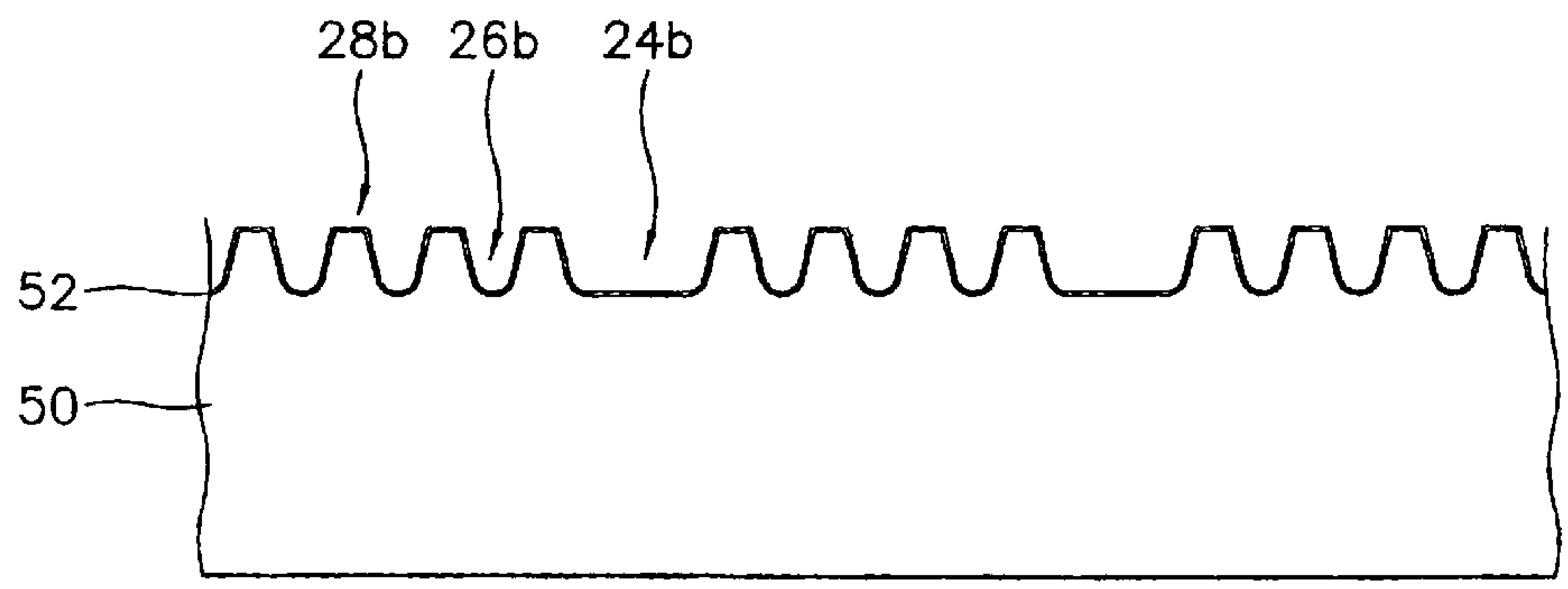


FIG. 10A

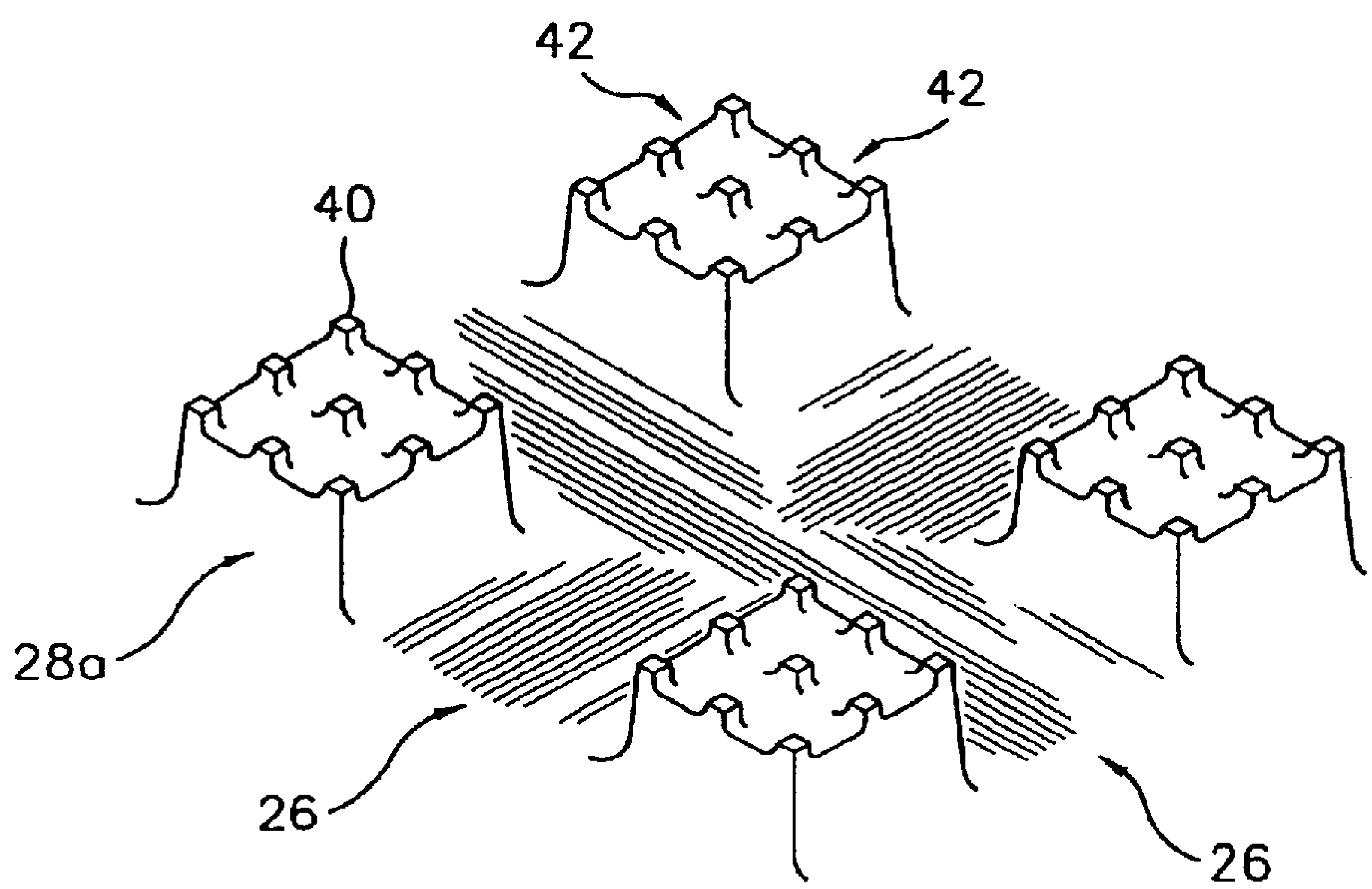


FIG. 10B

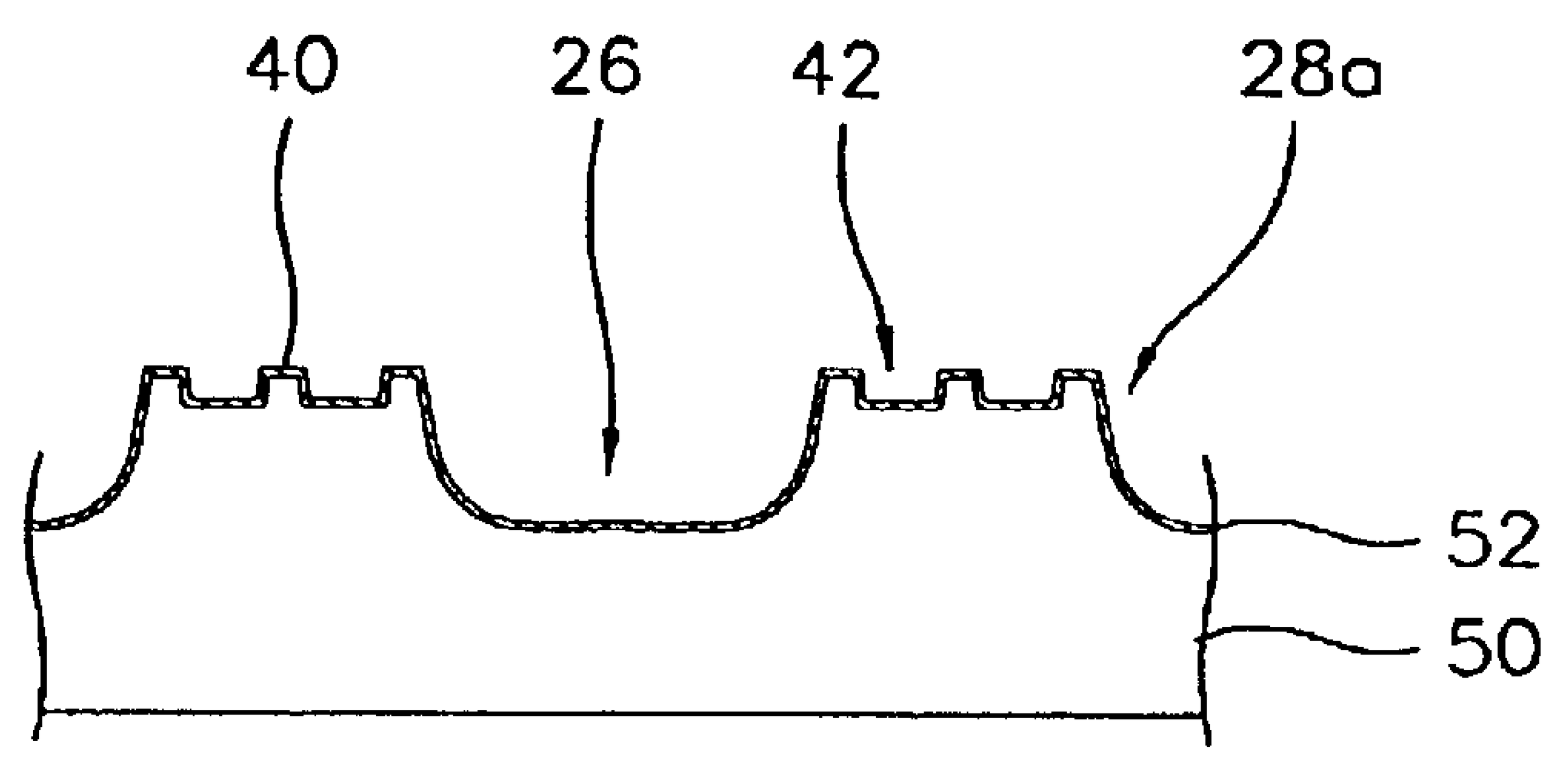


FIG. 11A

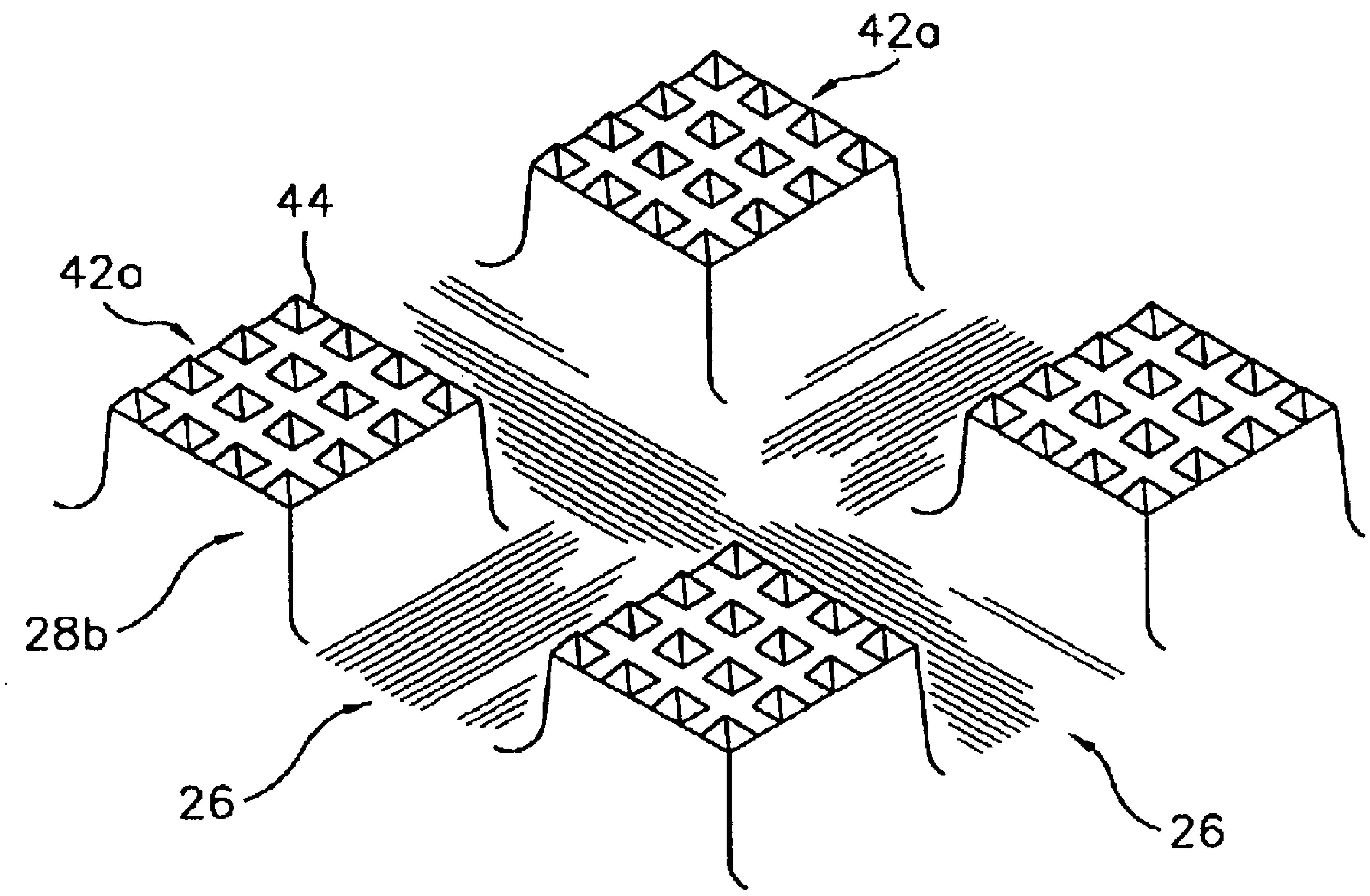


FIG. 11B

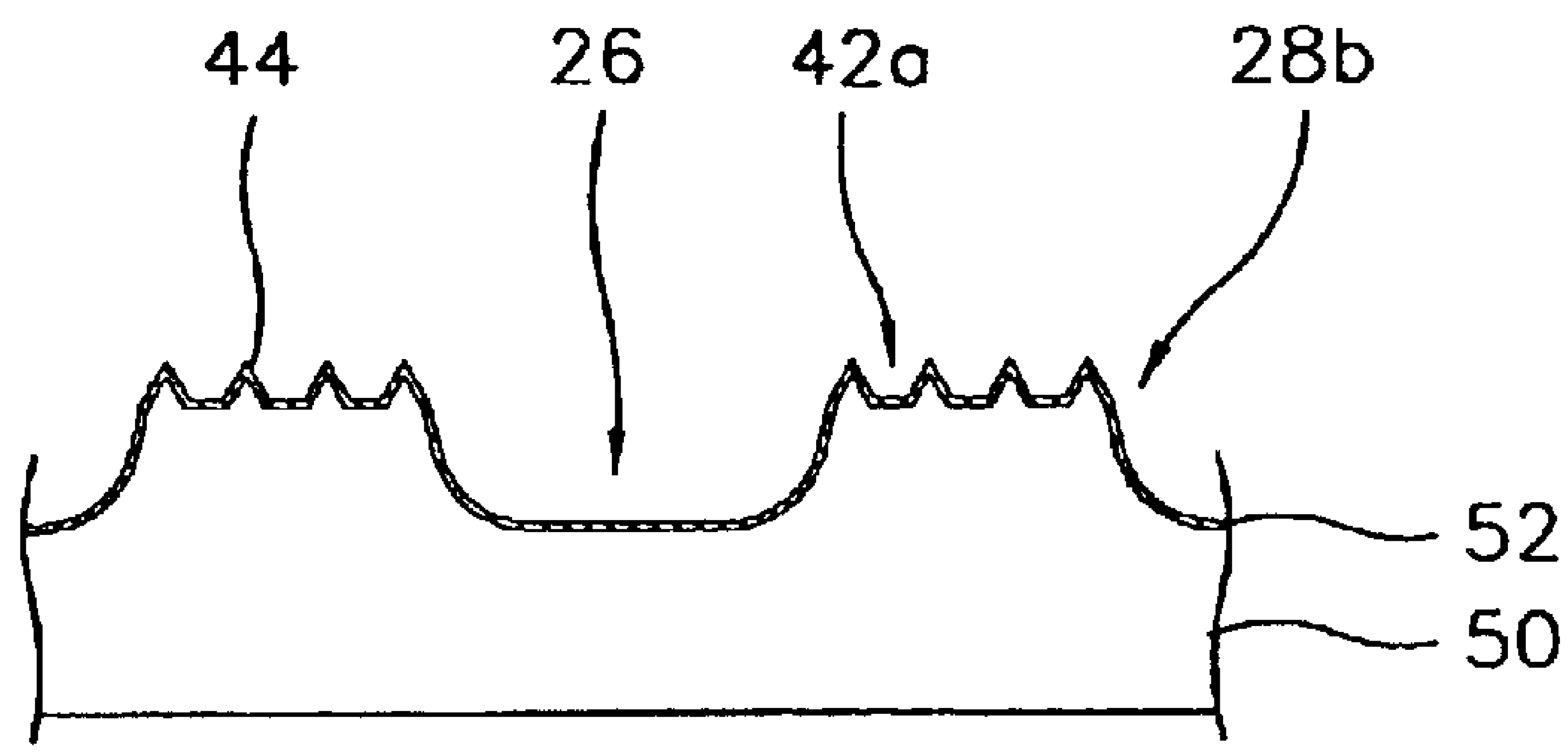


FIG. 12A

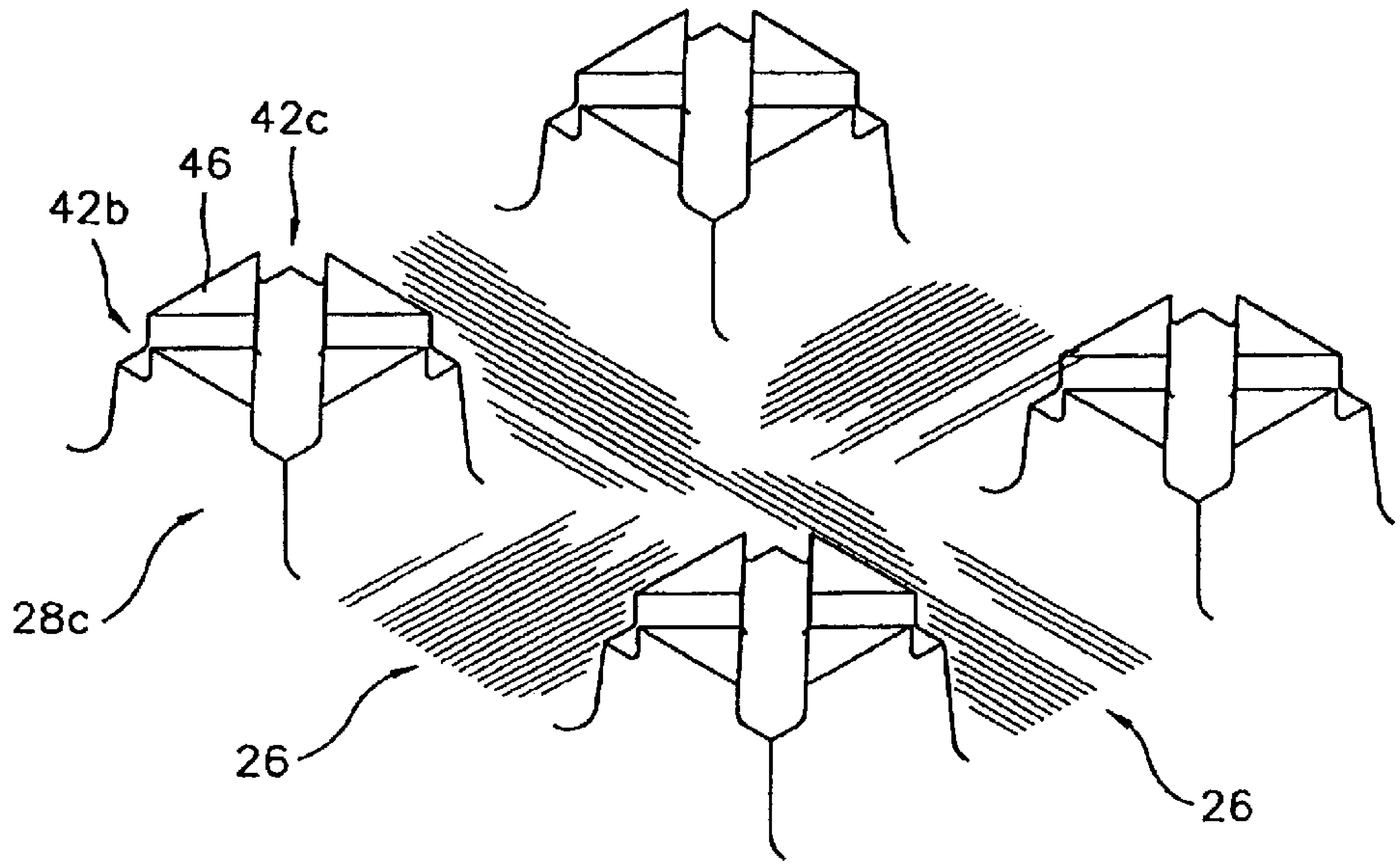


FIG. 12B

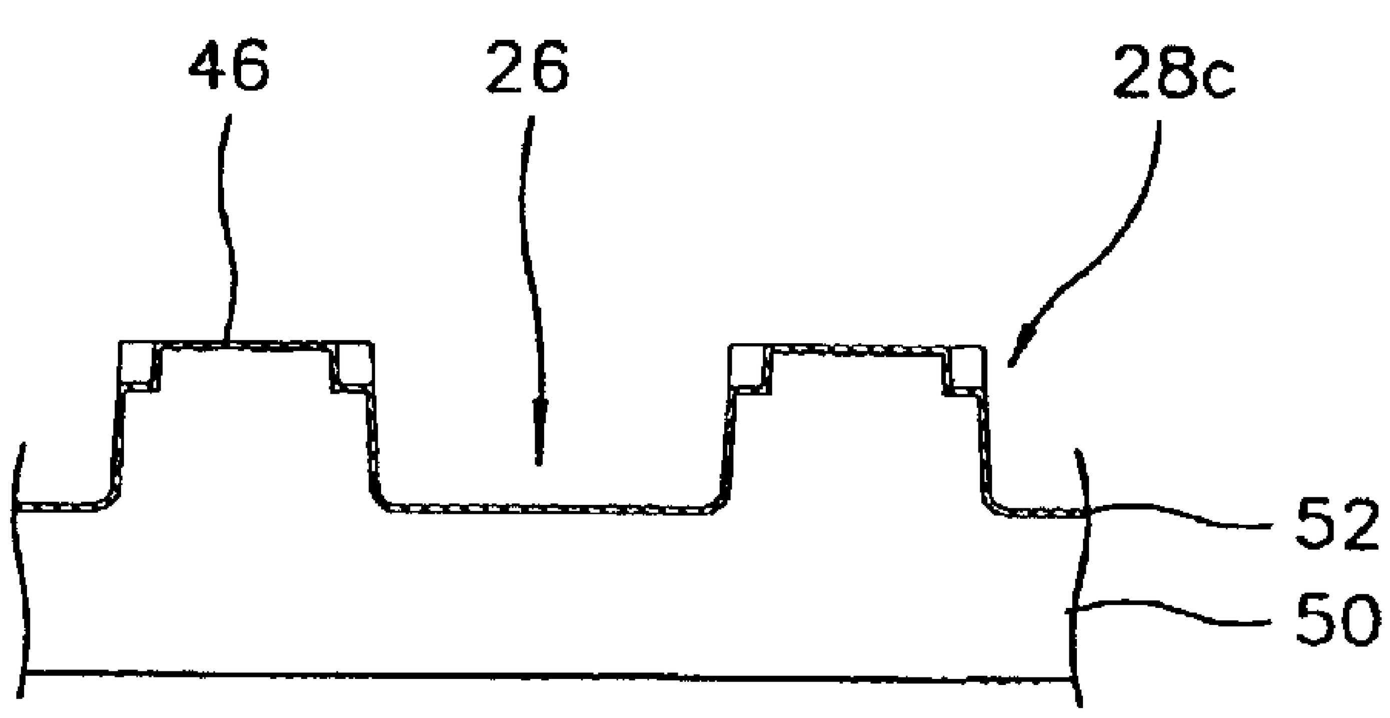


FIG. 13A

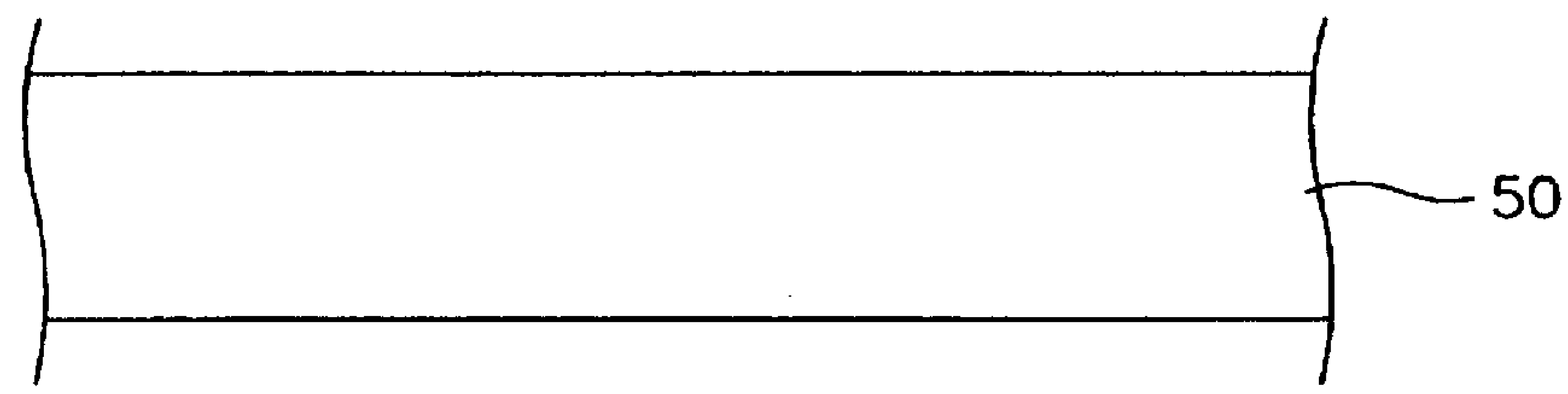


FIG. 13B

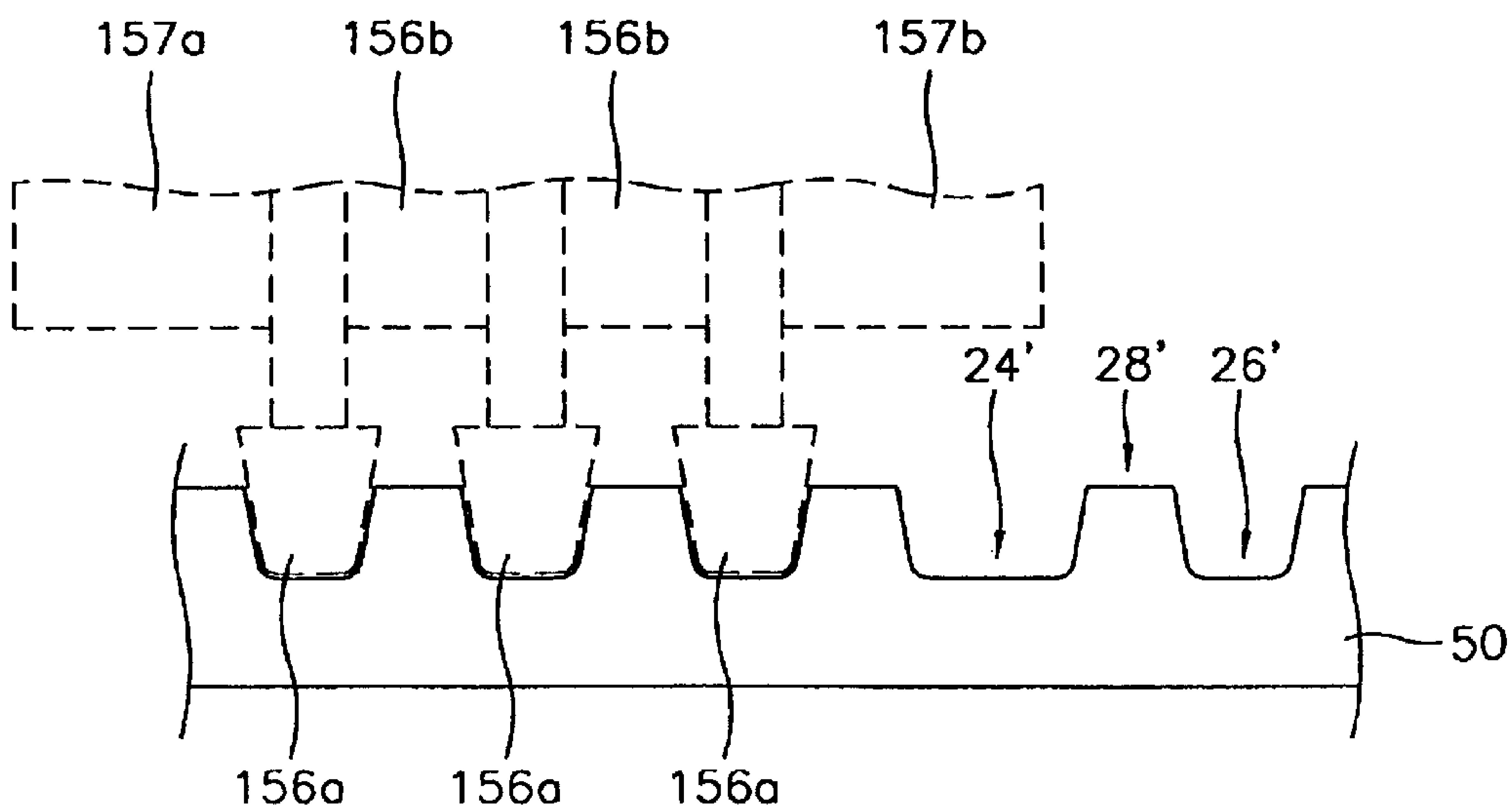


FIG. 13C

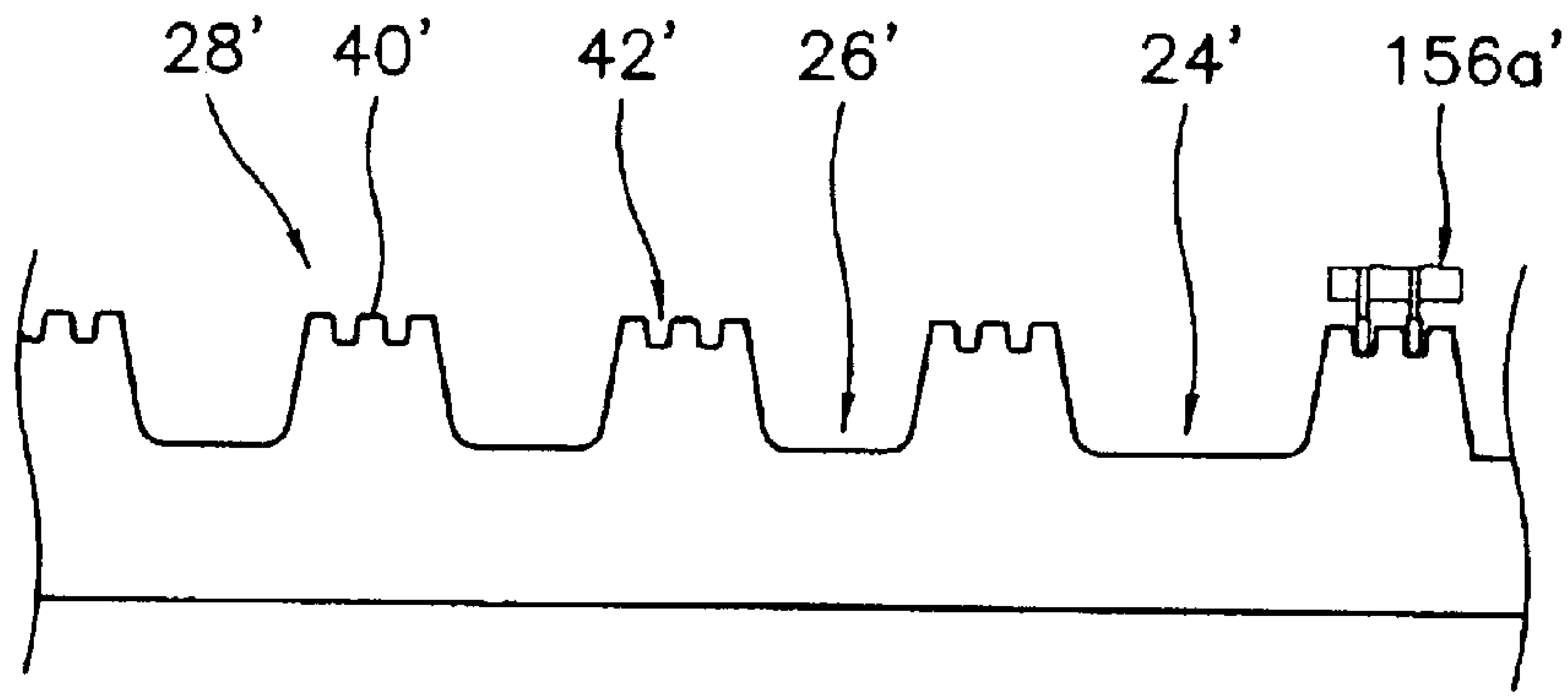
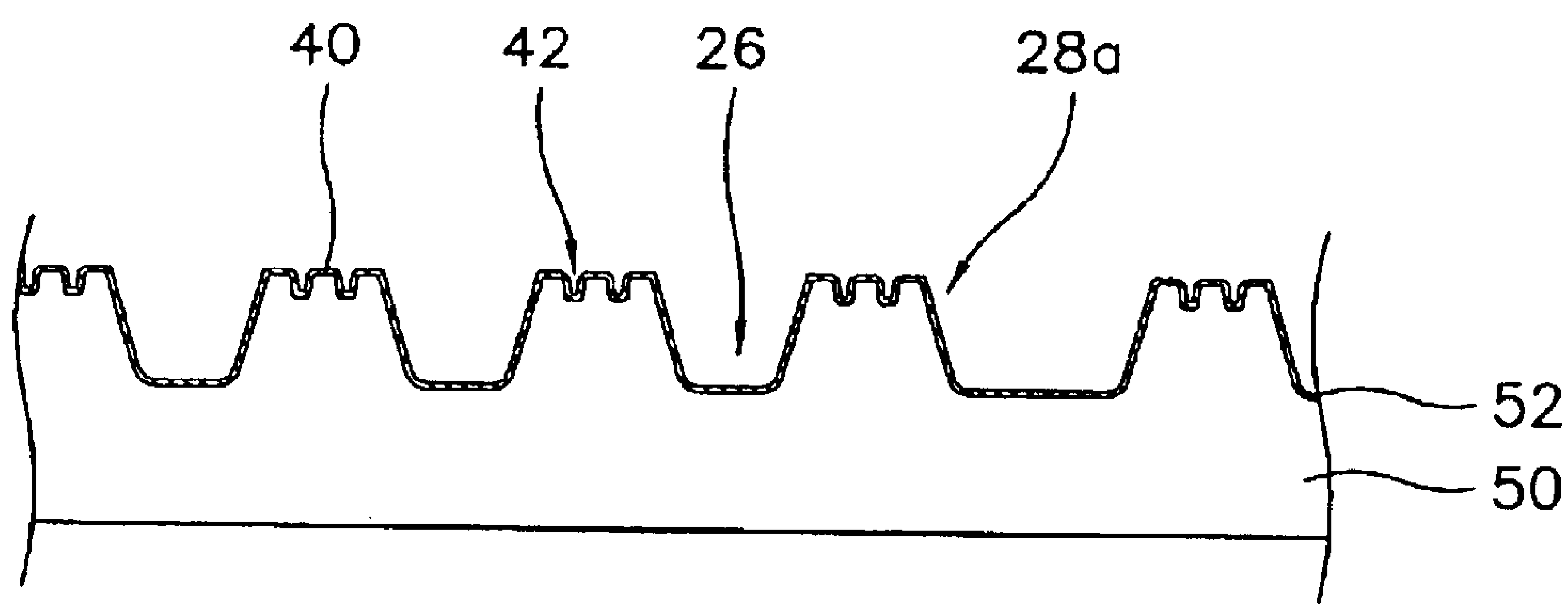


FIG. 13D



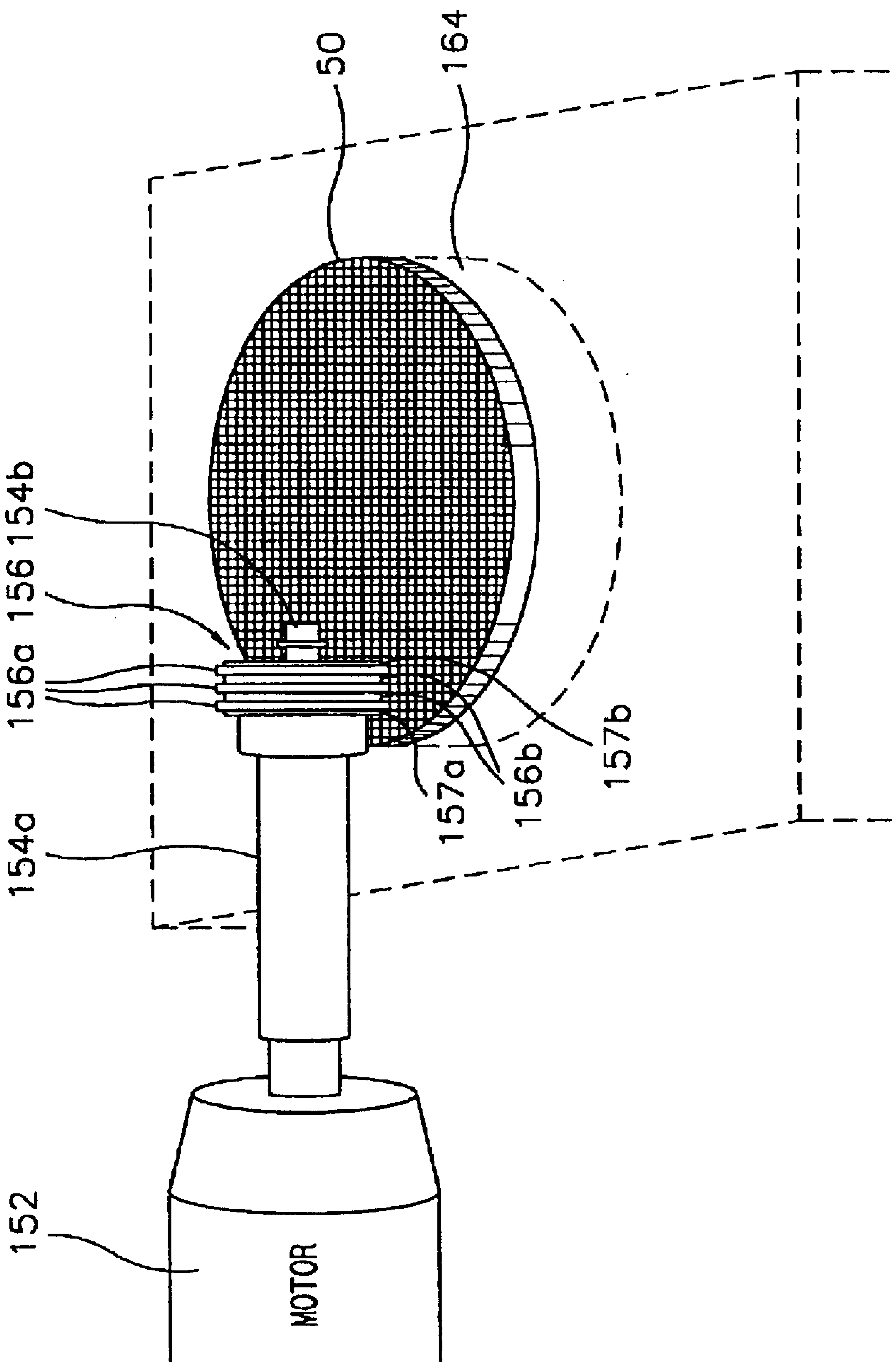


FIG. 14

FIG. 15

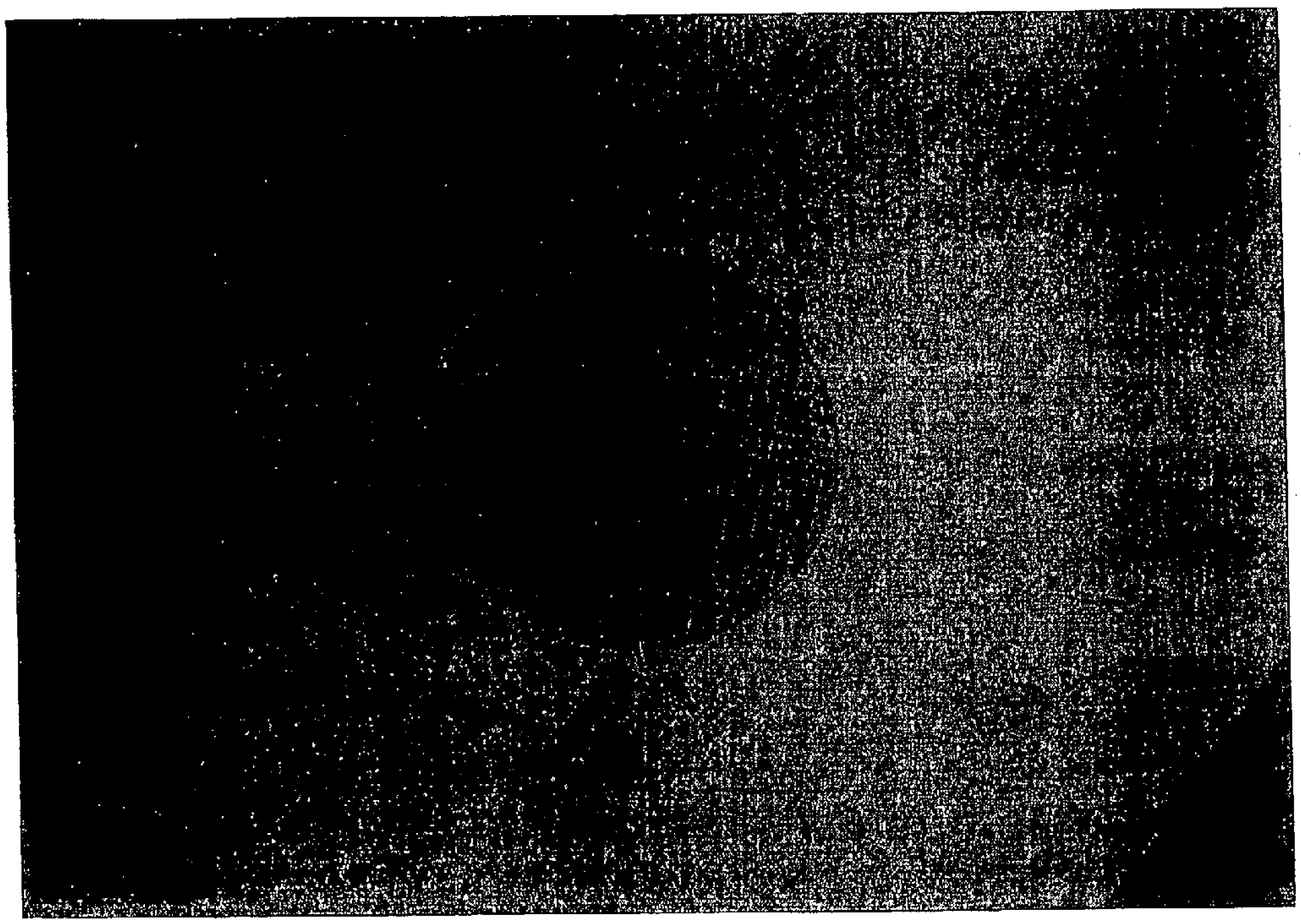


FIG. 16A

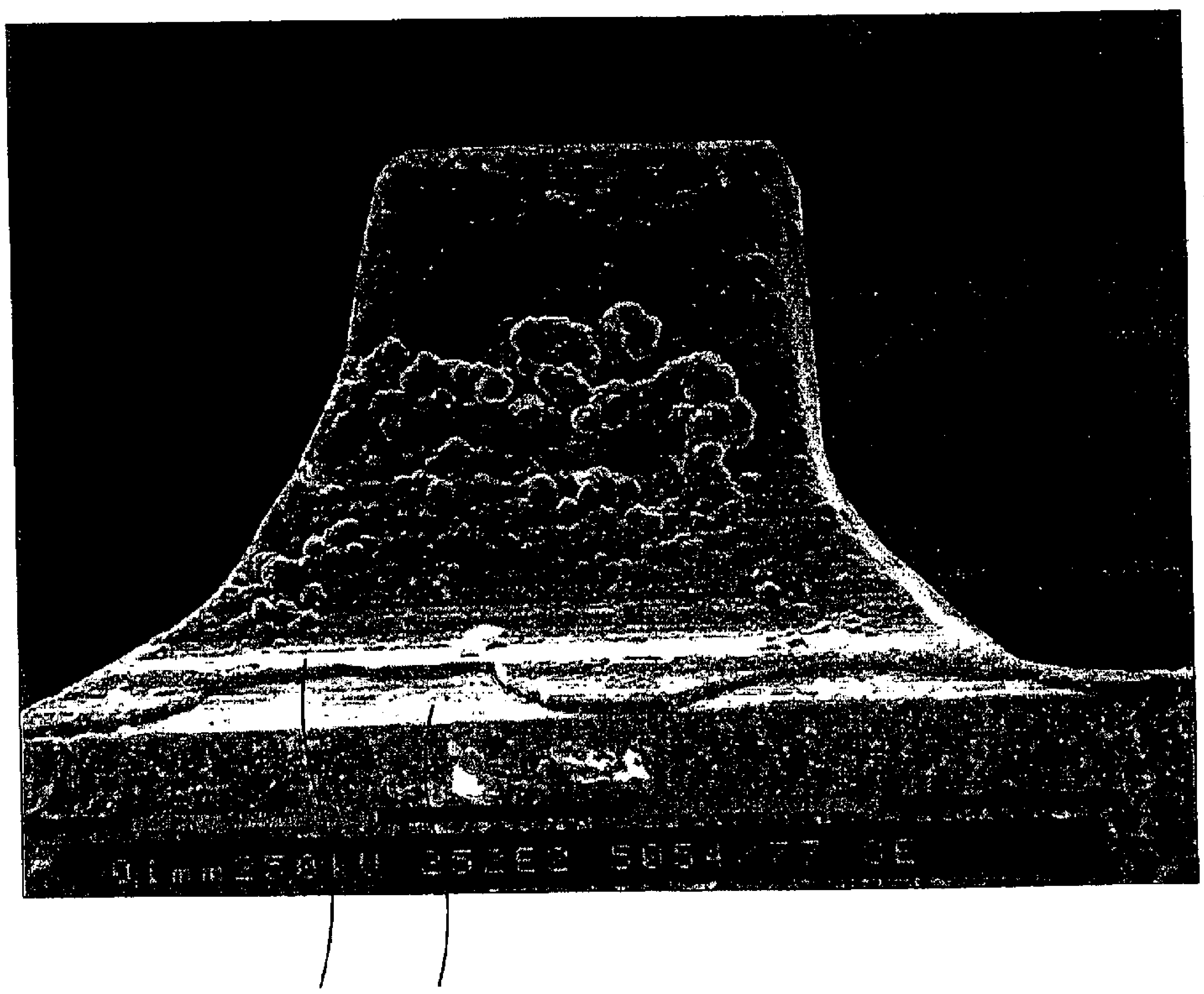


FIG. 16B

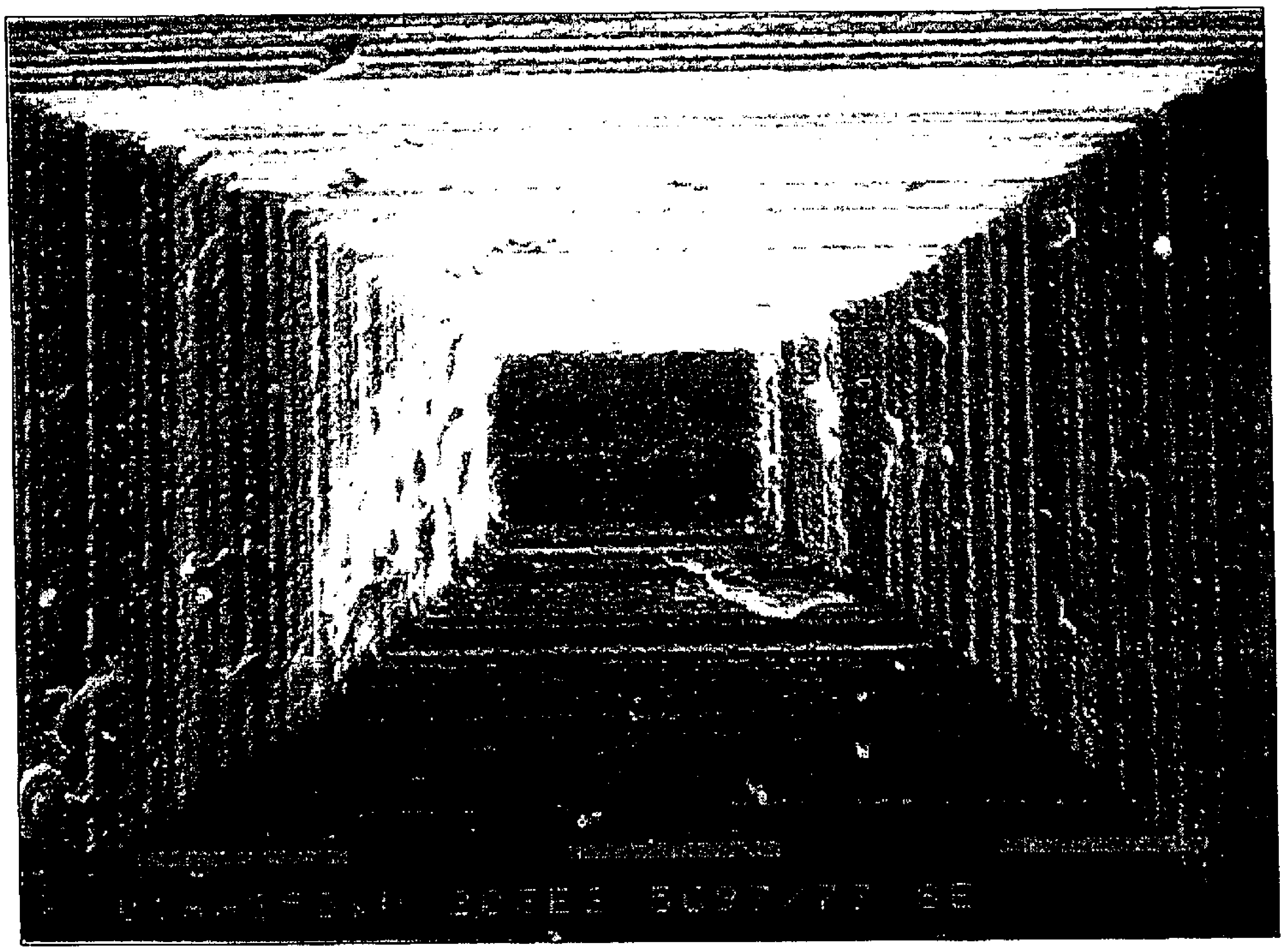


FIG. 16C

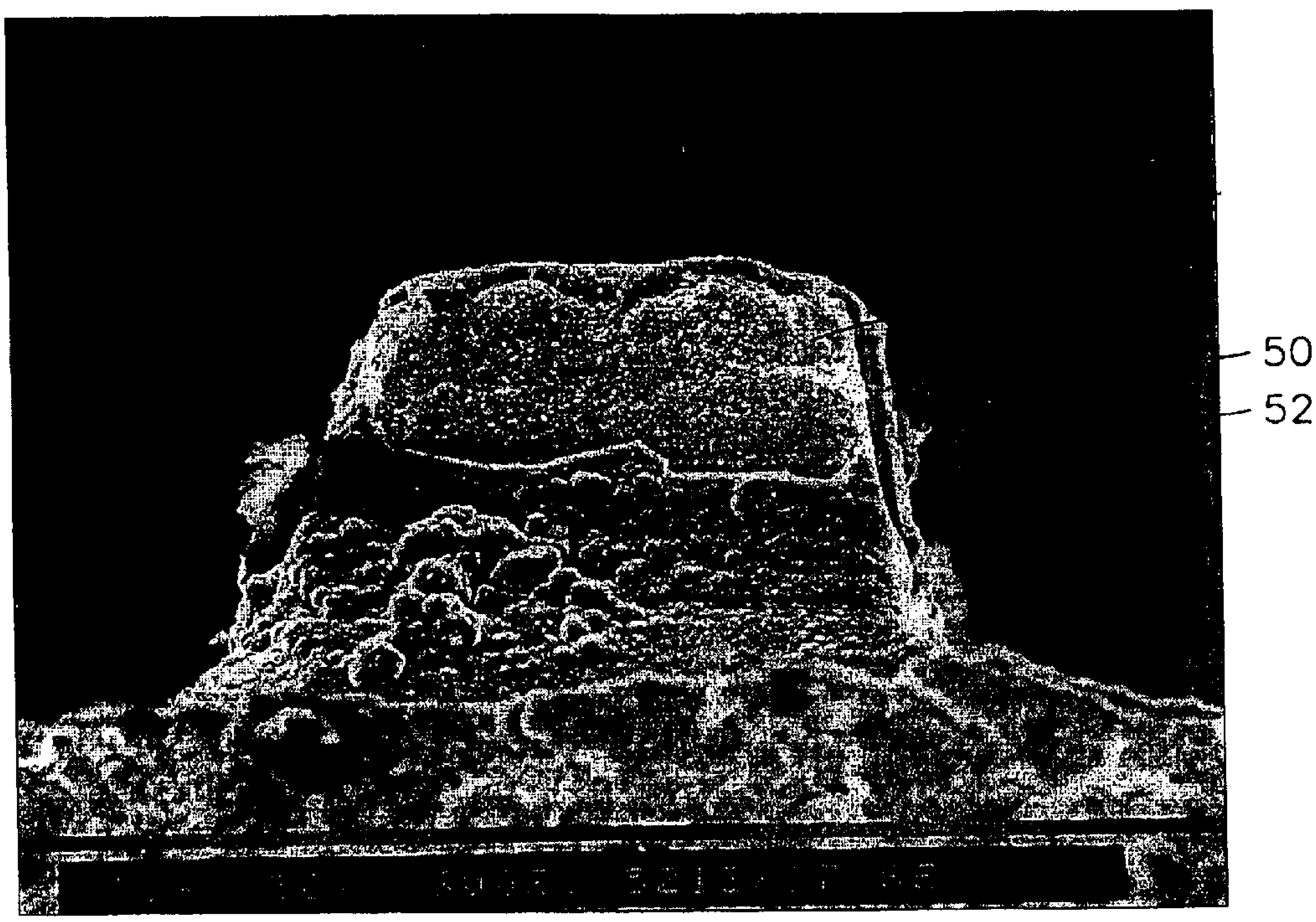


FIG. 17

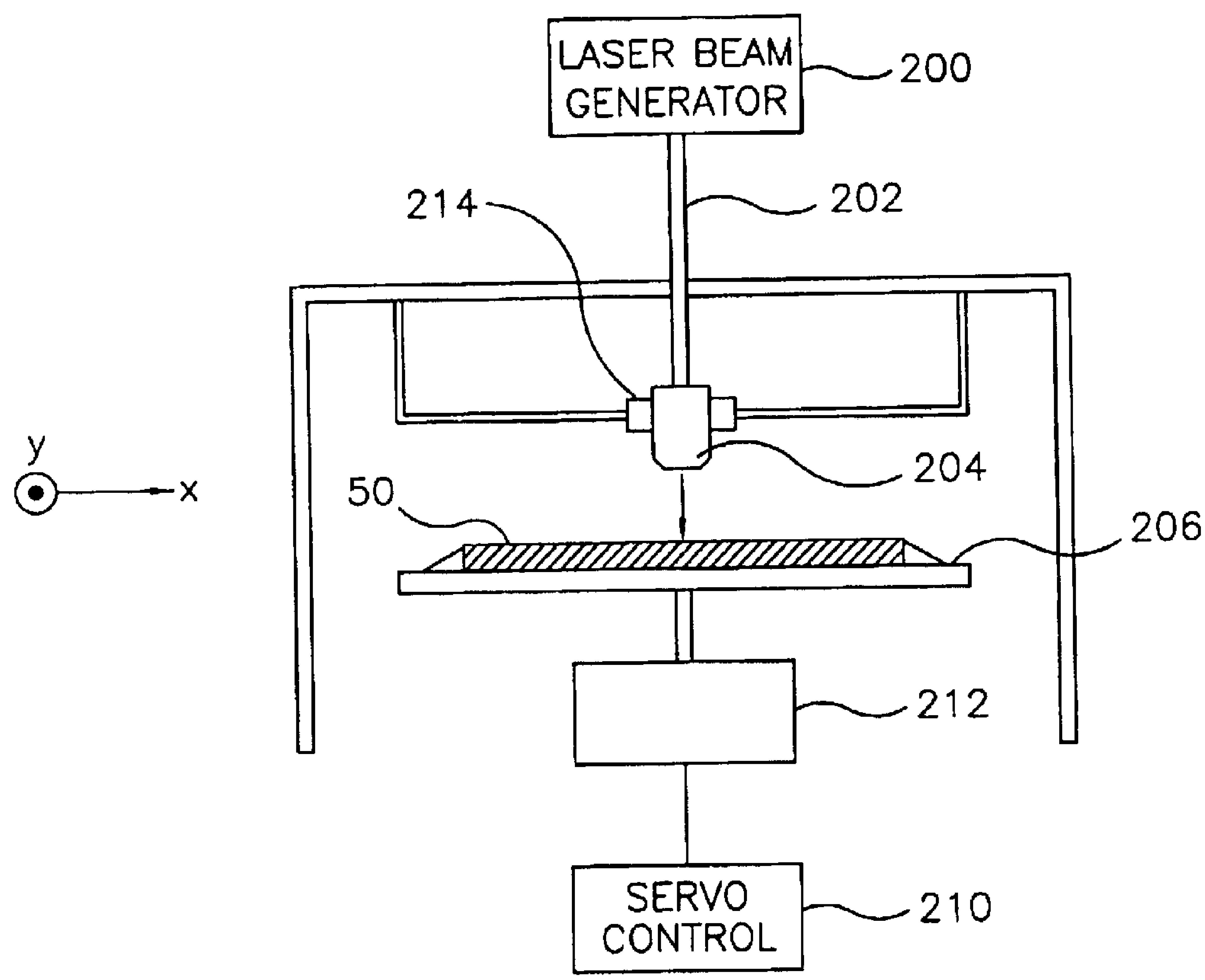

LASER BEAM GENERATOR
200
214
202
y
x
204
50
206
212
SERVO CONTROL
210

FIG. 18

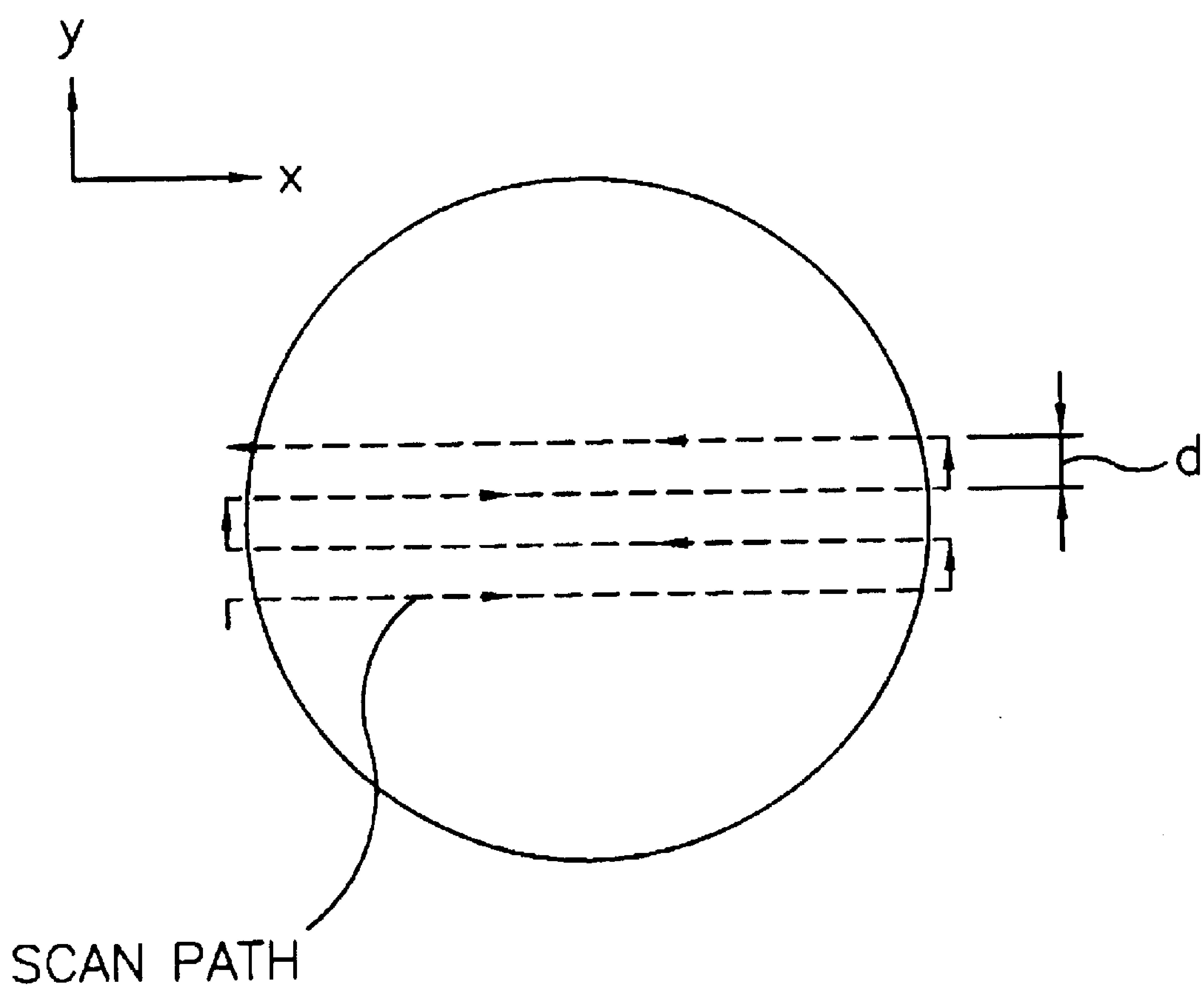


FIG. 19A

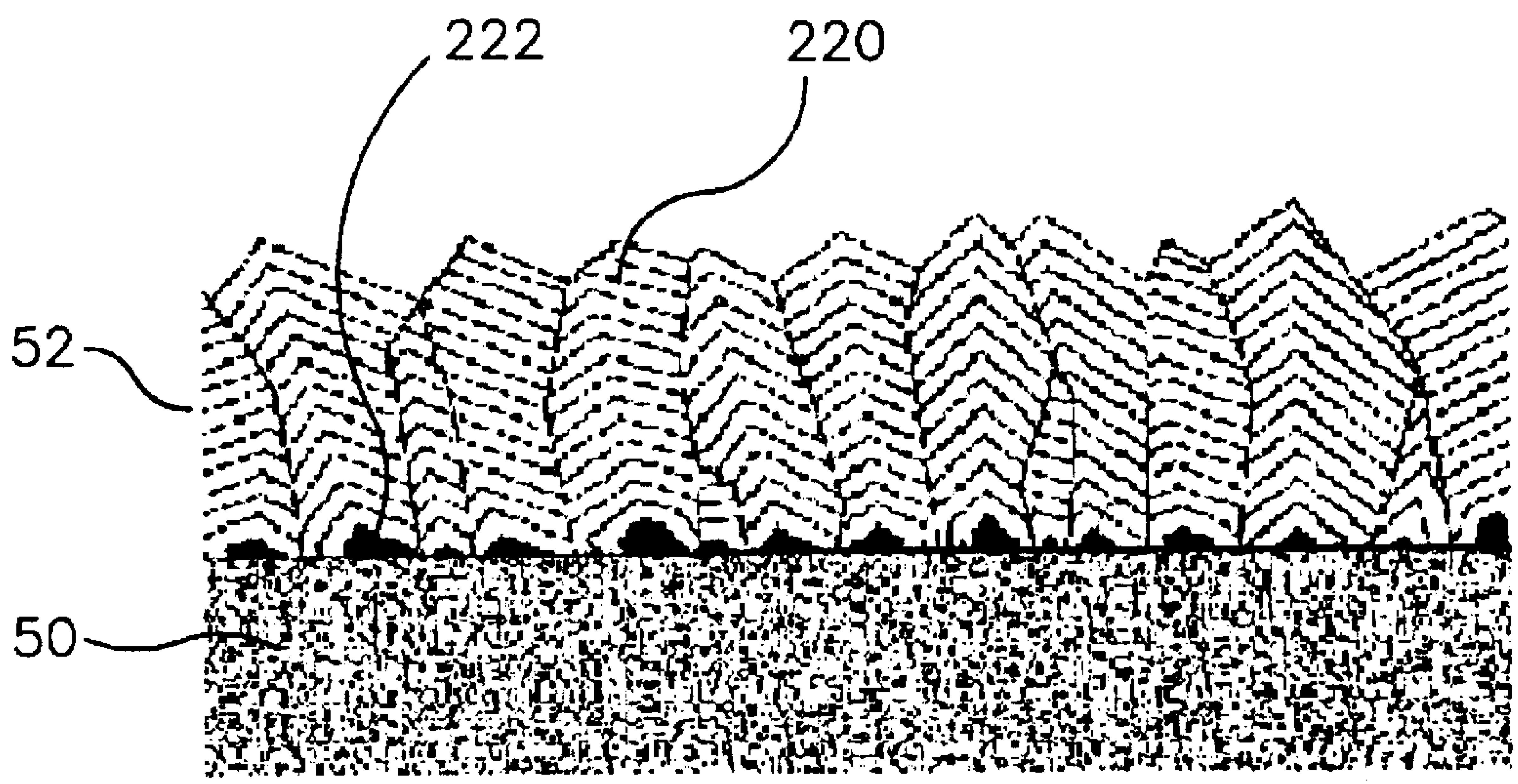
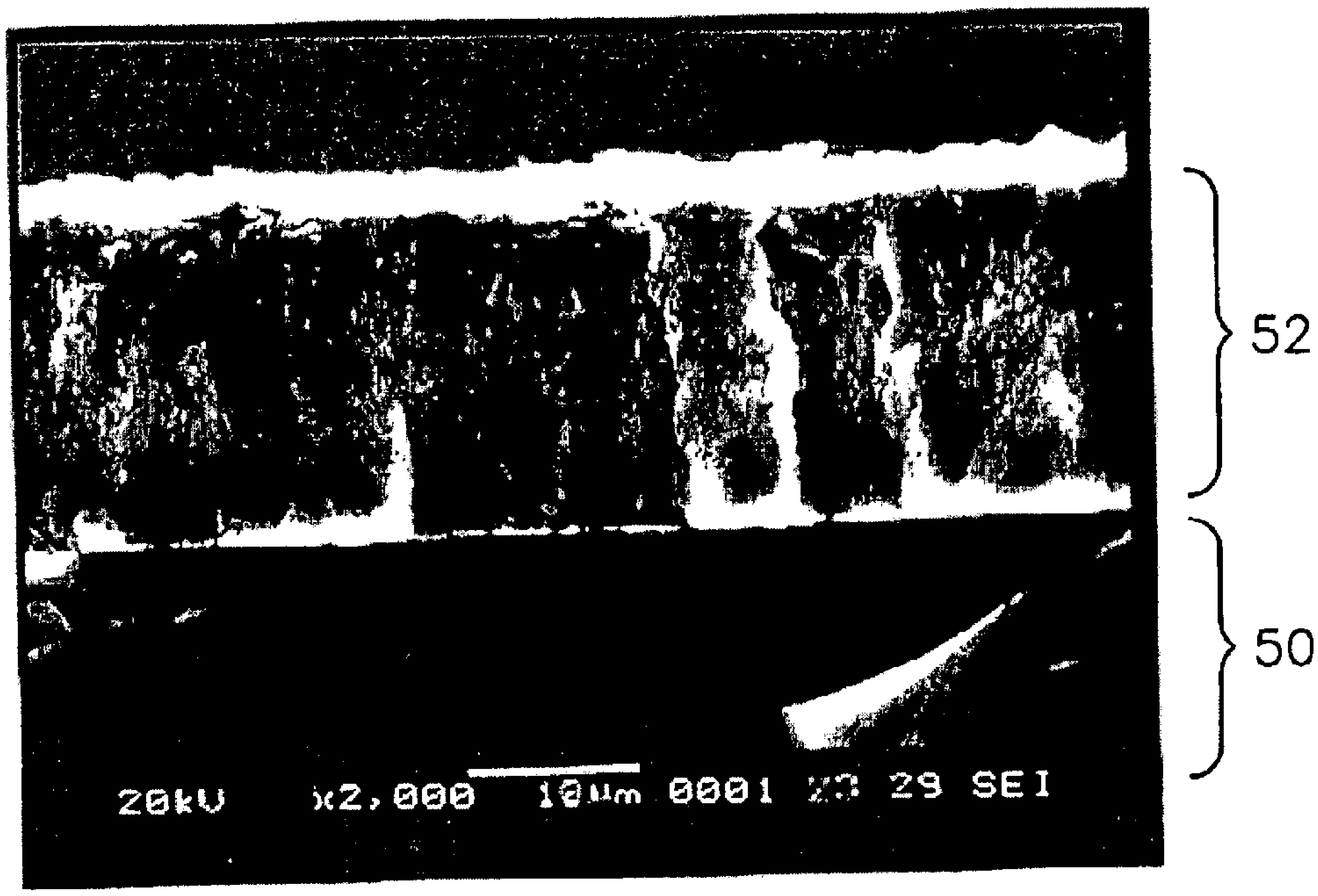


FIG. 19B



CONDITIONER FOR POLISHING PAD AND METHOD FOR MANUFACTURING THE SAME

CROSS REFERENCE TO RELATED APPLICATIONS

This is a continuation in part of U.S. patent application Ser. No. 09/521,035 filed Mar. 8, 2000, now U.S. Pat. No. 6,439,986, and entitled "CONDITIONER FOR POLISHING PAD AND METHOD FOR MANUFACTURING THE SAME" and which is incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a conditioner for polishing pad and a method for manufacturing the same, and more particularly to a conditioner for polishing pad to be used in chemical mechanical polishing (CMP) process and a method for manufacturing the same.

2. Description of the Prior Art

Generally, chemical mechanical polishing is widely used in the manufacturing process of semiconductor devices to obtain smooth and even surfaced wafers. Typically, a wafer to be polished is held by a carrier positioned on a polishing pad attached above a rotating platen (not shown), then by applying slurry to the pad and pressure to the carrier, the wafer is polished by relative movements of the platen and the carrier. A conventional polishing pad used for chemical mechanical polishing process generally comprises a multitude of fine holes having a diameter size of 30–70 m for exhibiting pumping effect when pressure is applied to the polishing pad to achieve a high removal rate. However, after a prolonged use, the holes wear out and become deposited with polishing residues, causing an uneven surface of the polishing pad. As a result, its ability to polish wafers decreases in time and the effectiveness of CMP process of achieving an uniformly even wafer surface becomes diminished.

To recover the polishing performance and to compensate for the uneven surface of the polishing pads, conditioning process utilizing a conditioner for removing the uneven surface of the polishing pads is commonly implemented by CMP process.

FIGS. **1**A to **1**C show a structure of a diamond conditioner used for conditioning polishing pads, which is manufactured by conventional electro-deposition method. Such diamond conditioner is typically made from an electro-plated diamond disk in which diamond particles **16** are scattered onto a stainless steel body portion **10** and electro-deposited by bonding metal **18** such as nickel or made from a brazed diamond disk in which diamond particles **16** are fixed onto the body portion **10** by melting the bonding metal **18**.

However, the conditioners made from such electro-deposition and braze methods have cutting surfaces of an uneven height caused by irregular distribution and varying sizes of the diamond particles **16** as illustrated by a cutting portion **12** in FIG. **1**C. Particularly, having diamond particles with diameter size beyond the range of 150–250 m in the conditioner cutting surface causes an undesirable surface roughness.

Further, because the conditioners having the above structure polishes wafers by making partial point contact and due to obtuse cutting angles of diamond particles, the cutting efficiency obtained by such conditioners is low. As such, in order to improve the cutting efficiency, it is necessary to

apply high pressure in the conventional conditioning processes. In conventional polishing pads having a dual-pad structure commonly made from polyurethane material, CMP is carried out in top pad while bottom pad provides pressure required for the conditioning process. When high pressure is applied to the top pad by conditioner during the conditioning process, due to the compressibility of the bottom pad, the conditioning cannot be smoothly carried out. Thus, maintaining a flat and leveled polishing pad surface becomes a difficult task.

More, the conditioners made from electro-deposition and brazed methods does not provide grooves or ditches for draining particles from the polishing pads. As a result, residual particles deposit and accumulate on the conditioner surface, which further attributes to decreasing the conditioning effectiveness.

Conventionally, the conditioning process can be carried out simultaneously with CMP process. Such in-situ conditioning process are classified into oxide or metal CMP processes by the type of slurry used for the polishing process, which is typically constituted by silica, alumina or ceria polishing materials. The slurry used for oxide CMP generally has a pH value within 10–12, while the slurry used for metal CMP has a pH value less than 4, and the bonding metal **18** used for fixing the diamond particles **16** onto the cutting surface of the conditioner is nickel, chromium or the like metals. In implementing either oxide or metal CMP in-situ conditioning process, because the polishing process is simultaneously carried out with conditioning process, the bonding metal **18** holding the diamond particles **16** is also affected by slurry, resulting in frequent detachments of the diamond particles **16** from the conditioner surface. Further, in metal CMP in-situ conditioning process, the strong acid property of the slurry used for the process has a tendency to corrode the bonding metal **18** to weaken its bonding effect, which ultimately causes the detachments of the diamond particles **16**.

The detached diamond particles **16** usually attach to the surface of the polishing pads and impart fatal scratches to the wafer surface during the polishing process to cause high defective rates in the semiconductor manufacturing process. Consequently, the polishing pads must be frequently replaced.

Further, metal ions from the eroded bonding metal **18** in metal CMP in-situ conditioning process often attaches to metal lines of the wafer circuits to cause short-circuits. In addition, metal ions from the in-situ conditioning process substantially attributes to the metal ion contamination of the wafers, and because the resulting semiconductor defects caused by the contamination are detected at the later manufacturing stages, its impact in the loss incurred from the defects is considerable in the industry.

SUMMARY OF THE INVENTION

In view of the foregoing, it is an object of the present invention to provide a conditioner for polishing pad which has an excellent and uniform degree of surface roughness for preventing defects caused from the detachments of diamond particles and metal ion contamination and for effectively conditioning the polishing pads in absence of high pressure in chemical mechanical polishing process for the semiconductor wafers.

It is a second object of the present invention to provide a method for manufacturing a conditioner for polishing pad which has the characteristics and functions of the above described conditioner.

According to the present invention, there is provided a conditioner for polishing pad comprises a substrate having integrally formed with a plurality of geometrical protrusions in an uniformed height on at least one side of the substrate and a diamond layer of an uniformed thickness formed substantially on a whole surface of the substrate side having geometrical protrusions.

It is preferred that the above geometrical protrusions have rectangular or cylindrical shapes and have flat and even upper surfaces. Optionally, the upper surfaces of the geometrical protrusions can have a plurality of smaller geometrical protrusions formed by a pair of diagonally-crossed grooves having U or V cross-sectional shapes or by a number of crossed-strips of grooves having U or V cross-sectional shapes. The smaller geometrical protrusions formed on the upper surfaces of the geometrical protrusions have a plane-view shape of triangle, rectangle or rectangular pyramid.

The plurality of geometrical protrusions integrally formed on the surface of the substrate has a crossed-strip pattern realized by crossing-strips of ditches having U or V cross-sectional shapes, where the U or V cross-sectional shapes are defined by a side portion of the geometrical protrusions and a bottom portion of the ditches. The crossing-strips of ditches all have same width and or depth, or alternatively a ditch having a greater width and or depth can be formed at an interval of a certain number of ditches on the crossed-strip pattern as a region dividing ditch.

The substrate is not limited by any shapes as long as a plurality of geometrical protrusions can be realized on its surface. For example, the substrate can have a shape of a disk, a doughnut or a plate having multiple corners, or on one side of substrate an outer ring portion can be formed raised above a middle portion to obtain a substrate having a cross-sectional profile of a cup. Alternatively, the doughnut shape substrate can have an outer belt portion having formed with a number of segmented portions separated by valleys radially expanding from a center of the substrate on which a plurality of geometrical protrusions can be formed.

The diamond layer is thinly and evenly deposited on the substrate surface by chemical vapor deposition (CVD) method.

It is preferred that the substrate is made from ceramic or cemented carbide materials.

The conditioner of the present invention further comprises a body portion formed at a side opposite to the side having formed with geometrical protrusions, which functions to link the conditioner with conditioning equipments. It is preferred that the body portion is made from stainless steel, engineering plastic or ceramic.

In another preferred aspect of the present invention, the conditioner has a segmented shape, in which the body portion has a cross-sectional shape of a doughnut with flattened upper and lower surfaces or a cross-sectional shape of a cup. The conditioner also comprises a number of independent segmented cutting portions separated by a certain distance and fixedly attached to one of surfaces of the body portion to take on a shape of a belt, where the independent segmented cutting portions are realized on their respective substrates made from ceramic or cemented carbide materials. Further, a diamond layer having an uniform thickness is substantially formed on the whole surface of the substrate.

The conditioner of the present invention having a structure of various-types of shape is manufactured by a method comprising the steps of a) forming crossed-strips of ditches

on a substrate having a certain shape to form a plurality of geometrical protrusions in an uniformed height on a surface of the substrate by utilizing a strong cutting wheel such as diamond wheel, and b) forming a diamond layer of an uniformed thickness coated substantially on a whole surface of the substrate processed by step a) by chemical vapor deposition (CVD).

Prior to implementing step b), the method can optionally comprise the step of forming a certain number of grooves in predetermined crossing directions to form a plurality of smaller geometrical protrusions in an uniform height on surfaces of the geometrical protrusions by grind and or cutting processes.

The substrate to be formed with ditches can have a plurality of shapes as already described earlier and the geometrical protrusions are realized by recessed depressions of ditches formed by grind and or cutting processes. The ditches formed in a layout of crossed-strips renders the resulting geometrical protrusions to have a pattern of crossed-strips on the substrate surface.

Prior to implementing step a), it is preferred that the method further comprises the steps of subjecting the substrate to fine grinding and lapping processes to obtain an uniform surface on at least one side of the substrate and to obtain substantially parallel substrate surfaces.

Alternatively, the step of forming geometrical protrusions on the substrate surface as outlined in step a) can be implemented by molding process in which a predetermined molding composition is injected and cooled in a mold having the shape of a substrate with geometrical protrusions.

The method may further comprises the step of attaching a body portion to the substrate at a side opposite to the side having formed with geometrical protrusions for linking the conditioner to conditioning device.

It is preferred that the substrate is made from ceramic or cemented carbide materials and the body portion is made from stainless steel, engineering plastic, ceramic or the like material.

BRIEF DESCRIPTION OF THE DRAWINGS

The above objects and other advantages of the present invention will become more apparent by describing in detail embodiments thereof with reference to the attached drawings in which:

FIGS. **1**A to **1**C show a conventional conditioner for polishing pad, wherein FIG. **1**A is a plane-view, FIG. **1**B is a cross-sectional view taken from line **1**B—**1**B of FIG. **1**A, and FIG. **1**C is an enlarged cross-sectional view showing a portion of the conventional conditioner;

FIGS. **2**A to **2**D show a conditioner for polishing pad manufactured from a substrate having a disk shape according to a first preferred embodiment of the present invention, wherein FIG. **2**A is a plane-view, FIG. **2**B is a cross-sectional view taken from line **2**B—**2**B of FIG. **2**A, and FIGS. **2**C and **2**D are respective enlarged plane and cross-sectional views showing body and cutting portions of the conditioner;

FIG. **2**E is a plane-view of a conditioner manufactured from a substrate having a disk shape according to another preferred embodiment of the present invention;

FIG. **2**F is an enlarged plane-view showing body and cutting portions of a conditioner manufactured from a substrate having a disk shape according to yet another preferred embodiment of the present invention;

FIGS. **3**A and **3**B show a conditioner manufactured from a substrate having a doughnut shape according to the present invention, wherein FIG. **3**A is a plane-view and FIG. **3**B is a cross-sectional view taken from line **3**B—**3**B of FIG. **3**A;

FIGS. **4**A and **4**B show a conditioner manufactured from a doughnut shape substrate having a number of segmented portions separated by valleys on one of its surfaces according to even yet another preferred embodiment of the present invention, wherein FIG. **4**A is a plane-view and FIG. **4**B is a cross-sectional view taken from line **4**B—**4**B of FIG. **4**A;

FIGS. **5**A and **5**B show a conditioner having a cup shape manufactured by attaching a body portion to a doughnut shape substrate according to even yet another preferred embodiment of the present invention, wherein FIG. **5**A is a plane-view and FIG. **5**B is a cross-sectional view taken from line **5**B—**5**B of FIG. **5**A;

FIGS. **6**A and **6**B show a conditioner manufactured by forming a segmented cutting portion having a shape of a belt on a surface of a doughnut shape substrate according to even yet another preferred embodiment of the present invention, wherein FIG. **6**A is a plane-view and FIG. **6**B is a cross-sectional view taken from line **6**B—**6**B of FIG. **6**A;

FIGS. **7**A and **7**B are enlarged perspective and cross-sectional views of the conditioner illustrated in FIG. **2**E, showing a surface structure of a cutting portion having an uniform layout of a plurality of rectangular geometrical protrusions;

FIGS. **8**A and **8**B are enlarged perspective and cross-sectional views of the conditioner illustrated in FIG. **2**A, showing a surface structure of a cutting portion having regionally grouped rectangular geometrical protrusions;

FIGS. **9**A and **9**B are enlarged perspective and cross-sectional views of a conditioner of the present invention, showing a surface structure of a cutting portion having regionally grouped cylindrical geometrical protrusions;

FIGS. **10**A and **10**B are enlarged perspective and cross-sectional views of rectangular geometrical protrusions of a conditioner of the present invention, showing a surface structure of the geometrical protrusions having formed with a plurality of smaller rectangular geometrical protrusions;

FIGS. **11**A and **11**B are enlarged perspective and cross-sectional views of rectangular geometrical protrusions of a conditioner of the present invention, showing a surface structure of the geometrical protrusions having formed with a plurality of smaller geometrical protrusions having a shape of rectangular pyramid;

FIGS. **12**A and **12**B are enlarged perspective and cross-sectional views of rectangular geometrical protrusions of a conditioner of the present invention, showing a surface structure of the geometrical protrusions having formed with smaller triangular geometrical protrusions by a pair of diagonally-crossed grooves;

FIGS. **13**A to **13**D are cross-sectional views illustrating a method for manufacturing a cutting portion of a conditioner according to the present invention;

FIG. **14** is a view illustrating a diamond wheel attached to a polishing equipment for manufacturing a substrate;

FIG. **15** is an actual photograph which shows a cutting portion of a conditioner manufactured by method of the present invention;

FIGS. **16**A and **16**B are electron-microscope photographs showing side and top-views of a rectangular geometrical protrusion formed on a cutting portion of a conditioner manufactured by method of the present invention; and

FIG. **16**C is an electron-microscope photograph showing a side view of a rectangular geometrical protrusion on which a portion had been chipped away to distinguish and illustrate a diamond layer formed on a substrate manufactured by method of the present invention.

FIG. **17** shows an exemplary constitution of a laser beam machining apparatus.

FIG. **18** shows a scanning path of a laser head to the substrate.

FIG. **19**A is a microscopic sectional view that depicts a diamond growth model of the diamond layer using diamond seeds.

FIG. **19**B is a SEM picture of a sectional shape of an actual conditioner manufactured in accordance with the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The preferred embodiment of the present invention will be described in detail below. The following embodiment is provided to further illustrate the invention and are not intended to limit the scope of the present invention.

First, a conditioner of the present invention can be realized with a structure selected from a range of diverse shapes and arrangements, and the preferred embodiments of a conditioner having various structural shapes manufactured according to the present invention will now be described in detail below.

Referring to FIG. **2**A, a body portion **20** is made from a material having anti-corrosive and chemically stable properties such as but not limited to teflon or stainless steel, and a shape of the body portion **20** is obtained by turning or grinding process or by molding process.

The body portion **20** tightly coupled or attached to a cutting portion **22** serves to link a conditioner of the present invention to a motor rotating portion (not shown) of conditioning equipments. The body portion **20** can have a wide range of shapes. For example, if the body portion **20** is connected to the cutting portion **22** having geometrical protrusions raised above the surface of the body portion **20**, the body portion **20** takes on a shape of a cup or a doughnut with flattened upper and lower surfaces. However the body portion **20** and its function is not necessarily required to realize the present invention. Indeed, in one of the preferred embodiments, the cutting portion **22** can be directly linked to the conditioning equipment without having the body portion **20**. Accordingly, the preferred embodiments of the present invention have been made in view of the structure of the cutting portion **22**, and more specifically in view of the shapes and arrangements of the surface structure.

Preferred Embodiment 1

FIGS. **2**A to **2**F show a conditioner having a disk shape according to a first preferred embodiment of the present invention. The conditioner comprises a body portion **20**, a cutting portion **22**, and a substrate **50**.

As shown by FIGS. **2**A to **2**D, the cutting portion **22** has a plurality of rectangular geometrical protrusions **28** formed in regional units of crossed-strip pattern on a surface of the substrate **50**. FIGS. **8**A and **8**B are enlarged perspective and cross-sectional views which closely show the crossed-strip pattern of the rectangular geometrical protrusions **28** of the cutting portion **22**.

The substrate **50** is preferably made from a ceramic material such as Si or Si_3N_4, or from at least one ceramic material selected from the group consisting of Al_2O_3, AlN, TiO_2, ZrOx, SiO_2, SiC, SiOxNy, WNx, Wox, DLC (diamond like coating), BN, and Cr_2O_3. Alternatively, the substrate **50** can be made from a cemented carbide material such as tungsten carbides (WC) selected from the group consisting of tungsten carbonite-cobalt (WC—Co), tungsten carbonite-carbon titanium-cobalt (WC—TiC—Co), and tungsten carbonite-carbon titanium-carbon tantalium-cobalt (WC—TiC—TaC—Co). The substrate **50** can also be made from other cemented carbide materials such as TiCN, B_4C, or TiB_2.

The substrate **50** preferably has a disk shape, but it can have a shape of a plate having multiple corners, and it is important that the substrate **50** has a smooth surface exhibiting uniform degree of roughness, since the shape of the rectangular geometrical protrusions **28** must be maintained after a diamond layer **52** has been formed on a whole surface of the substrate **50** to obtain a conditioner having a highly effective cutting ability.

The rectangular geometrical protrusions **28** having an uniform height are formed on one side of the substrate **50** by recessed crossed-strips of ditches **24** and **26** having a cross-sectional profile of U-shape. More specifically, side and bottom portions of recessed ditches **24** and **26** has a rounded shape and their width gradually decreases toward the bottom portion to give the rectangular geometrical protrusions **28** a broader and thicker base. As a result, the rectangular geometrical protrusions **28** having such structure strengthen a rigid and brittle nature desired for the substrate surface. Alternatively, the ditches **24** and **26** has a cross-sectional view of V-shape.

The ditch **24** is a region dividing ditch and the ditch **26** is a cell dividing ditch which divides or separates each rectangular geometrical protrusions **28** on the substrate surface. As shown by FIGS. **2**A to **2**D, the region dividing ditch **24** which has a greater width and or depth than that of the cell dividing ditch **26** is placed a regular interval of a certain number of the cell dividing ditch **28**. For example, as shown by FIGS. **2**A to **2**D, the ditch **24** can be placed at every fourth ditch in both crossing directions to regionally divide the rectangular geometrical protrusions into a group of 4×4. Here, the ditches **24** and **26** functions to drain particle residues from polishing pads during the conditioning process.

As shown by FIG. **2**A, a region diving ditch **25** having an even greater width and or depth than the ditches **24** and **26** can be placed at a center of the substrate surface in crossed-strips to more effectively drain the particle residues.

The diamond layer **52** covering the whole surface of the substrate **50** is thinly and uniformly formed on the surfaces of the rectangular geometrical protrusions **28** and the ditches **24**, **25** and **26** of the cutting portion **22**.

FIG. **15** is an actual photograph which shows the cutting portion **22** manufactured by method just described above. The cutting portion **22** has a diameter and thickness of 100×4t.

FIGS. **16**A to **16**C are electron-microscope photographs showing the rectangular protrusion **28** having coated with the diamond layer **52** of the cutting portion **22** of the present preferred embodiment. FIGS. **16**A and **16**B show side and top-views of the rectangular geometrical protrusion **28**, while FIG. **16**C shows another side view of the rectangular geometrical protrusion **28** on which a portion had been chipped away to visually distinguish and illustrate the diamond layer **52** formed on the surface of the cutting portion **22** of the substrate **50**. As it can be seen from the electron-microscope photographs, the diamond layer **52** deposited on the surfaces of the rectangular geometrical protrusion **28** and the ditches **24** and **26** of the substrate **50** has a thin and uniform thickness.

Preferred Embodiment 2

In the present embodiment, various and alternative arrangements the geometrical protrusions can have on the substrate surface are realized by varying the layout and structure of the ditches. As shown by FIG. **2**E, the ditches of a same shape can be formed on a cutting portion **22*a*** in the substrate surface by having a same width and or depth. FIGS. **7**A and **7**B show enlarged perspective and cross-sectional views of an arrangement of the geometrical protrusion formed by the ditches of FIG. **2**E. For this arrangement, it is preferred that the ditches **26*a*** has a greater width and or depth than that of the ditches **26** shown in FIG. **2**A for effectively draining the polishing pad residues from the surface of the cutting portion **22*a***.

Preferred Embodiment 3

In the present embodiment, various shapes of the geometrical protrusions are realized. The shape of the geometrical protrusions **28** is not limited by rectangular shape, and alternatively, as shown by FIG. **2**F, the geometrical protrusions **28*b*** formed on a cutting portion **22*b*** has a cylindrical shape. FIGS. **9**A and **9**B show enlarged perspective and cross-sectional views of the cutting portion **22*b*** having formed with cylindrical geometrical protrusions **28*b*** which are also segmented by ditches **24*b*** and **26*b***. Similar to the substrate having rectangular geometrical protrusions, the substrate having formed with cylindrical geometrical protrusions **28*b*** on its cutting portion **22*b*** has a diamond layer **52**. The layout arrangement of the cylindrical geometrical protrusions **28*b*** can have the same pattern illustrated in the first and second preferred embodiment or it can be realized by having a radial strip pattern expanding from the center of the substrate.

Preferred Embodiment 4

The geometrical protrusions of the previous preferred embodiments have a flat and even upper surface, but in the present embodiment the upper surfaces of the geometrical protrusions are formed with a plurality of smaller rectangular geometrical protrusions **40** having a crossed-strip pattern. FIGS. **10**A and **10**B show perspective and cross-sectional views of the rectangular geometrical protrusions **28*a*** having formed with smaller rectangular geometrical protrusions **40** on their surfaces. As shown, the ditches **26** are the same as illustrated in the previous embodiments, and a diamond layer **52** is also coated on the surface of the substrate **50**.

The smaller rectangular geometrical protrusions **40** are formed on the upper surfaces of the rectangular geometrical protrusions **28*a*** of the substrate **50** by forming crossed-strips of recessed grooves **42**. Similar to the ditches, the grooves **42** being round in its side and bottom portions have a cross-sectional profile of U-shape. A width of the grooves **42** decreases toward its bottom portion to give the smaller rectangular geometrical protrusions **40** a broader and thicker base. The rectangular geometrical protrusions **28*a*** and the smaller rectangular geometrical protrusions **40** both having such a wider base structure attribute to strengthen a rigid nature desired for the substrate surface. Alternatively, the grooves **42** can have a cross-sectional view of V-shape. The presence of the smaller rectangular geometrical protrusions **40** will more effectively drain the polishing pad residues from the surface of the resulting conditioner to enhance the efficiency of the conditioning process.

It is preferred that the ditches and the grooves have an U-shape cross-sectional profile in contrast to V-shape. Generally, the ditches and grooves having the U-shape cross-sectional profile are more efficient in draining conditioning residues from the substrate surface simply due to their wider bottom portions. Further, in addition to the cross-sectional shapes of the ditches and grooves, the draining efficiency is also affected by the size and layout pattern of the ditches and grooves. Thus, various combinations of the above factors can be realized to obtain a desired draining efficiency.

Preferred Embodiment 5

In the present embodiment, a plurality of smaller geometrical protrusions **44** having a shape of rectangular pyramid is formed on upper surfaces of the rectangular geometrical protrusions **28***b* of the substrate **50**. As shown by FIGS. **11**A and **11**B, pointed upper ends of the smaller rectangular pyramid geometrical protrusions **44** are obtained by forming grooves **42***a* adjacent to each other in a crossed-strip pattern. Here, the pointed upper ends of the smaller rectangular pyramid geometrical protrusions **44** makes a point contact with the polishing pad surface during the conditioning process.

The cutting efficiency of a conditioner having the rectangular geometrical protrusions with flat upper surfaces is higher by making line or surface contacts with the polishing pad surface as opposed to a conditioner that makes a point contact. However, because of an uniform height and size of the smaller rectangular pyramid geometrical protrusions **44** formed on the upper surfaces of the rectangular geometrical protrusions, which is different from the irregular height of the cutting surface of the conventional conditioner shown in FIG. **1**C, the cutting efficiency of a conditioner realized by the present embodiment which make a point contact with the polishing pad surface is not significantly lower than the conditioners which make line or surface contacts.

Preferred Embodiment 6

In the present embodiment, a four smaller geometrical protrusions **46** having a triangular shape are formed on upper surfaces of each rectangular geometrical protrusions **28***c* of the substrate **50** by diagonally crossed grooves **42***b* and **42***c*. FIGS. **12**A and **12**B are perspective and cross-sectional views showing the present embodiment. In terms of draining effectiveness and making contact with the polishing pad surface, the present embodiment having the rectangular geometrical protrusions **28***c* formed with smaller triangular geometrical protrusions **46** on their surfaces exhibits better draining than the rectangular geometrical protrusions **28** having flat upper surface and makes more contact with the polishing pad surface than the rectangular geometrical protrusions **28***a* and **28***b* having respectively formed with smaller rectangular geometrical protrusions **40** and smaller rectangular pyramid geometrical protrusions **44**.

Preferred Embodiment 7

In the previous embodiments, the geometrical protrusions **28**, **28***a*, **28***b* and **28***c* have been formed on one surface side the substrate **50** having a shape of a disk or a plate with multiple corners. However, the present invention can also be realized by implementing substrates having different shapes. In the present embodiment, a substrate **50***a* has a shape of a doughnut with flattened upper and lower surfaces.

FIGS. **3**A and **3**B show plane and cross-sectional views of the substrate **50***a* having a ring-shape cutting portion **22***c* on which the geometrical protrusions **28**, **28***a*, **28***b* or **28***c* described earlier are formed. Alternatively, a substrate can have a shape of a doughnut with one of its open surfaces enclosed to take on a shape of a cup. A diamond layer **52***a* is also coated on the substrate **50***a*.

FIGS. **5**A and **5**B are plane and cross-sectional views showing a conditioner having a shape of a cup, in which a substrate **50***c* having a shape of a doughnut with flattened upper and lower surfaces and being formed with a diamond layer **52***c* on a surface of a cutting portion **22***e* is attached to an upper surface of a body portion **20***a* having a shape of a cup.

Preferred Embodiment 8

In the present embodiment, a conditioner having segmented cutting portions is realized. As shown by FIGS. **4**A and **4**B, a substrate **50***b* having a shape of a doughnut with flattened upper and lower surfaces or a doughnut with one of its open surfaces enclosed has a number of segmented cutting portions **22***d* formed by recessed valleys **30** radially expanding from a center of the substrate **50***b*. The segmented cutting portions **22***d* are formed with the geometrical protrusions **28**, **28***a*, **28***b* or **28***c*, and the substrate **50***b* further comprises a diamond layer **52***d*.

FIGS. **6**A and **6**B show another variation of segmented cutting portions. A number of independent segmented cutting portions **22***f* fabricated from their respective substrates **50***d* and separated from each other in a certain distance are fixedly attached on a surface of a body portion **20***b* to take on a shape of a belt. The body portion **20***b* has a shape of a doughnut with flattened upper and lower surfaces or a shape of a doughnut with one of its open surfaces enclosed, and the substrates **50***d* each having segmented cutting portions **22***f* are coated with a diamond layer **52***d*.

In the above preferred embodiments, the geometrical protrusions having rectangular or cylindrical shapes have been exemplified. However, the geometrical protrusions can be realized with a wide range of shapes such as triangle or hexagonal shapes. Similarly, in the preferred embodiments, the rectangular geometrical protrusions preferably having a square shape have been exemplified, however, the geometrical protrusions can also be realized with various forms of four sided figure such rhombus.

Herein below, a method for manufacturing the preferred embodiments of a conditioner for polishing pad according to the present invention will now be described in detail with reference to the attached drawings.

First, a method for manufacturing a first preferred embodiment of a conditioner according to the present invention will be described below.

FIGS. **13**A to **13**D are cross-sectional views illustrating a method for manufacturing a cutting portion **22**, shown in FIGS. **10**A and **10**B, having the rectangular geometrical protrusions **28***a* being formed with smaller rectangular geometrical protrusions **40** on their surfaces.

First, a substrate **50** having a shape of a disk is made from the ceramic or cemented carbide materials recited earlier, then the substrate **50** is subjected to a fabrication process to obtain a diameter and thickness of 100×4t.

Next, one of the sides of the substrate **50** to be formed with a cutting portion is surface processed by rough and fine grinding processes utilizing a diamond wheel equipment to obtain an uniform and high degree of surface roughness, flatness, and parallelism. Then, the substrate **50** is subjected to a double-sided lapping process by utilizing a lapping equipment (not shown). Here, a cutting surface of the substrate **50** to be formed with rectangular geometrical protrusions is fine grinded until a high degree of flatness of 1 m is obtained.

Then, as shown by FIG. **13**B, crossed-strips of region dividing ditches **24**' and cell dividing ditches **26**' are formed on the cutting surface of the substrate **50** by utilizing a diamond wheel equipment shown in FIG. **14**. The diamond wheel equipment comprises a motor **152**, shafts **154***a* and **154***b*, and a wheel assembly **156** comprising diamond wheels **156***a*, spacers **156***b* placed between diamond wheels **156***a*, and flanges **157***a* and **157***b* placed at both ends of the wheel assembly **156**. The thickness of the diamond wheels **156***a* is determined by width of the ditches **24**' and **26**' to be formed, and the shape of the diamond wheels **156***a* should be round to impart the ditches **24**' and **26**' with U-shape cross-section. Hence, the width of the ditches **24**' and **26**' decreases toward their bottom portion and gives the resulting geometrical protrusions **28***a* a thicker and broader base, which results in strengthening the rigid and brittle nature of the substrate **50** made from ceramic or cemented carbide materials. Further, the round U-shape cross-section of the ditches **24**' and **26**' provide an additional function of draining polishing pad residues from the cutting surface of the conditioner.

Typically, the diamond wheels **156***a* have a diamond blade portion having diamond particles bonded to an end of its disk-type body by metal or resin boding, and a desired round curvature in the diamond layer of the diamond wheels **156***a* is better obtained when a resin bonded diamond wheel is used, as round curvature is more effectively obtained by removing resin bonding materials and diamond particles during a rounding process utilizing grinding stone.

The ditches **24**' and **26**' are formed by fixedly placing the substrate **50** on a processing platform **164**, then the processing platform having the substrate **50** is upwardly moved toward the rotating diamond wheels **156***a* to be cut. After grinding, the substrate is rotated in 90 degrees and again fixed on the processing platform **164** to repeat the previous cutting process for forming crossed-strips of the **24**' and **26**'. Here, for forming the region dividing ditch **24**', a diamond wheel **156***a* having a greater thickness than the diamond wheel **156***a* used for forming the cell dividing ditch **26**' is utilized. Widths of the resulting rectangular geometrical protrusions **28***a* is controlled by a gap between the diamond wheels **156***a*. Specifically, as the gap between the diamond wheels **156***a* decreases, a more narrow rectangular geometrical protrusions **28***a* can be formed. However, it is preferred that a distance of the gap should not be less than the thickness of the diamond wheel **156***a* to prevent fracturing of the rectangular geometrical protrusions **28** during the fabrication process. FIG. **10**A shows uniformly arranged rectangular geometrical protrusions **28***a* (prior to being formed with a diamond layer) formed by the above process. FIG. **15** is an actual photograph showing the rectangular geometrical protrusions formed on a cutting portion. The rectangular geometrical protrusions have a dimension of 190 m (length)×190 m (width)×200 m (height).

Referring to FIG. **13**C, crossed strips of grooves **42**' are formed on surfaces of the rectangular geometrical protrusions **28**' to form a plurality of smaller rectangular geometrical protrusions **40**' each having a dimension of 30 m×30 m×30 m by utilizing a diamond wheel **156***a'* having a smaller thickness. Here, the length, width and height of the smaller rectangular geometrical protrusions **40**' have same values, and similar to the rectangular geometrical protrusions **28**', the smaller rectangular geometrical protrusions **40**' have a thicker and wider base to strengthen and compensate the weak rigidness of substrates made from a ceramic material.

Edges of the smaller rectangular geometrical protrusions **40**' having an uniformed height processed by the above process further increase the cutting ability of the resulting conditioner by making line contact with the polishing pad surface, and at the same time, the smaller rectangular geometrical protrusions **40**' also increase the draining efficiency of the conditioner by assisting the drainage of slurry and particle residues from the cutting surface. Further, the rectangular geometrical protrusions **28**' having such smaller rectangular geometrical protrusions **40**' are effective in evenly distributing slurry during in-situ conditioning process.

There are other methods of forming the geometrical protrusions on the surface, for example, the method of laser-beam machining. As already described, the substrate is made from ceramic or cemented carbide materials. These materials are brittle and, difficult and costly to form in arbitrary shape. The laser beam machining method may be an appropriate choice for such materials.

Laser beam machining is introduced as a replacement of the above-mentioned diamond wheel machining. As the laser beam machining technique is a well-known art, a brief explanation thereon will be given hereinafter. FIG. **17** shows an exemplary constitution of a laser beam machining apparatus. The laser beam from a laser beam generator **200** is guided through a supply line **202** to a laser head **204** through which the laser beam is directed onto the surface of the substrate **50**. The substrate **50** is placed on a workpiece holder **206**. In order to make, for example, rectangular protrusions on the surface of the substrate **50**, the laser head **204** and/or the workpiece holder **206** should be controlled to move so that the laser beam can scan along a straight path, as shown in FIG. **18**, in the ±x-direction the surface of the substrate **50** while going ahead in the y-direction by a desired space d. For allowing this movement, the apparatus may have a servo mechanism **212** for actuating the workpiece holder **206**, a servo mechanism **214** for actuating the laser head **204**, and a servo control **210** for controlling the servo mechanisms **212** and **214**.

Machining conditions such as scanning speed, intensity and laser beam diameter, the desired space d and so on can be determined based on shape of the protrusions and depth of the grooves to be formed, melting characteristic of the substrate **50** and other factors. The incident angle of the laser beam is equal or less than 90°. When the incident angle is less than 90°, each of the geometrical protrusions formed can have a shape so that its bottom portion is thicker than its top portion. A scanning schedule of the laser beam should be programmed and installed in the servo control **210**. When programming the scanning schedule, it is preferable that irradiation conditions of the laser beam be taken into consideration.

When a laser beam is directed onto a surface of the substrate **50**, the surface temperature of the substrate rises sharply and the surface area irradiated by the laser beam is melted and then evaporated by the heat of the laser beam. A surface state of the trace along which the laser beam is scanned is rarely clean due to residues such as half-burned ashes. Accordingly, a successive cleaning process is required for eliminating the residues from the surface of the substrate **50**. Suitably controlled sand blasting of which target is confined within the trace of the laser beam can be used for the eliminating of the residues. After these machining and cleaning processes, the substrate **50** is subjected to the diamond coating process by CVD.

The laser machining method may be poorer in machining efficiency than the above-mentioned diamond wheel machining method. For a good cutting capability of the geometrical protrusions, it is preferable that a top surface and sidewalls of the geometrical protrusion make a sharp right or obtuse angle. However, using the principle of evaporation-by-heat for engraving the grooves, the laser machining method may result in a generally poorer shape of the top edges of the geometrical protrusions than the diamond wheel machining method.

Despite these disadvantages, the laser machining method has some merits. Firstly, the laser machining method is excellent in reproducibility. In a case of using the diamond machining method, the reproducibility of the grooves or the geometrical protrusions becomes poorer in accordance with time because the diamond wheel is worn out bit by bit in accordance with its use. However, the laser machining method is free from this problem. Next, the laser machining method is advantageous because any particular protrusion shapes, even the cylindrical protrusion shape which can be hardly made by the diamond wheel machining method, can be made by utilizing the laser machining method.

When the geometrical protrusions to be formed are very small, the laser beam machining is more advantageous than the diamond wheel machining. In this regard, the diamond wheel machining and the laser beam machining can be utilized in common for forming the geometrical protrusions. For example, in FIGS. **10**A and **10**B, the rectangular protrusions **28***a* may be formed by the diamond wheel machining while the smaller rectangular protrusions **40** are formed by laser beam machining.

As shown by FIG. **13**D, after being formed with smaller rectangular geometrical protrusions **40**', the substrate is then subjected to a chemical vapor deposition (CVD) process to form a diamond layer **52**. A widely used conventional CVD equipment is utilized for the CVD process having the following conditions outlined in Table 1. A four inch Si_3N_4 substrate was utilized to deposit the diamond layer **52**. The CH_4 gas is raw material gas and H_2 gas is used as a catalyst for the activation of the CH_4 gas under a plasma environment.

TABLE 1

conditions for the CVD process

Gas and Flow Rate	H_2 gas (1000 ml/min), CH_4 gas (20 ml/min)
Chamber Pressure	10 Torr
Temperature of filament	2200° C.
Applied Voltage	+100 Volt
Deposition Time	More than 8 hours

A diamond layer **52** having a thin and uniform thickness strongly adhering to the surface of the substrate **50** was obtained. Because of the thin and uniform thickness of the diamond layer **52**, the surface structure of the substrate **50** was maintained after the deposition process. The above conditions accompanying the chemical vapor deposition process represent one of many suitable conditions which can be applied for the CVD process in the present invention.

Several kinds of CVD processes are known including hot filament CVD, microwave plasma CVD, radio frequency plasma CVD, and electron-assisted CVD, and any one of them can be applied to the present invention. Hot filament CVD of diamond is recommendable as the best mode since it is superior to other CVD processes in view of process cost and deposition area. The process condition of table 1 is just an exemplary condition of an embodiment of the hot filament CVD process.

When coating the diamond layer **52** on the substrate **50** on which the geometrical protrusions are formed by the CVD process such as the hot filament CVD process, it is preferable to introduce a pre-treatment of the substrate **50** for enhancing the adhesion force between the diamond layer **52** and the substrate **50** in advance with a main process of the CVD coating since a lifetime of the conditioner is influenced mainly by the adhesion force. The main factors that influence the adhesion force are in the heat expansion coefficient between the diamond layer **52** and the substrate **50**, chemical and physical surface state of the substrate **50**, and diamond seed density on the substrate **50**.

For a clean surface state of the substrate **50**, any weakly bonded particles or remnants that may be made by the above-mentioned protrusion machining processes should be eliminated from the substrate **50**. When the substrate **50** is made from cemented carbide material for example tungsten carbide (WC), it contains in general coupling material such as Co, Ni and Fe in an amount of less than about 0.5%. These materials make the adhesion force weak because a graphite phase is formed in the boundary surface between the substrate **50** and the diamond layer **52**. Accordingly, in order to protect diffusion of Co into the diamond layer **52** it is preferable to coat an intermediate layer of Ti, TiN or W on the surface of the substrate **50**.

The adhesion force increases in accordance with the diamond seed density because a high diamond seed density can provide a wide contact area between the substrate **50** and the diamond layer **52**. It is preferable to introduce a process for making the diamond seed densely and rapidly prior to the main CVD process. For the making of the diamond seeds, a scratching process for forming minute scratches on the surface of the substrate **50** is employed. The scratches can be made by using minute diamond particles. Alternatively, an ultrasonic wave vibration process in which the substrate **50** is treated under diamond gas environment vibrated by an ultrasonic wave to implant microscopic diamond seeds in the skin of the substrate **50** is usable. FIG. **19**A is a microscopic sectional view that depicts a diamond growth model of the diamond layer **52** in which the growth diamonds **222** are originated from respective diamond seeds **220** on the skin of the substrate **50** made from ceramic. FIG. **19**B is a SEM picture of a sectional shape of a real conditioner manufactured in accordance with the present invention which makes the diamond layer **52** by the CVD process after preparing the diamond seeds **220**.

After forming the diamond layer **52** on the substrate surface, a pre-fabricated body portion **20** is fixedly attached to the substrate **50**. The body portion **20** functions to link the resulting conditioner to the conditioning equipments for better controlling the process of cutting the polishing pads. Alternatively, without compensating the function of the body portion **20**, a conditioner can be realized without the body portion **20** as illustrated by the preferred embodiments.

The above method for manufacturing a conditioner has been described for the first preferred embodiment of the present invention. However, one skilled in art can manufacture other preferred embodiments of a conditioner by the method described above, such as the preferred embodiments shown and illustrated by FIGS. **2**E, **3**A, **4**A, and **5**A. Particularly, the preferred embodiment of a conditioner having segmented cutting portions shown in FIG. **6**A can be realized by subjecting a substrate **50***d* to a fine grinding process to obtain a highly leveled surface having a desired uniform roughness, followed by coating a diamond layer on the substrate **50***d* by CDV process. Then, the substrate **50***d* having the diamond layer is cut into independent segmented cutting portions which is fixed attached to the surface of the body portion **20***b* in an arrangement shown by FIG. **6**A.

Further, the smaller rectangular pyramid geometrical protrusions **44** shown in FIGS. **11**A and **11**B can be obtained by selecting the diamond wheel **156***a* having an appropriate thickness and rounded curvature at its outer diamond layer. Similarly, the smaller triangular geometrical protrusions **46** shown in FIGS. **12**A and **12**B can be obtained by utilizing an appropriate diamond wheel **156***a*. The rectangular geometrical protrusions having a flat surface as shown in FIGS. **7**A, **7**B, **8**A and **8**B can be directly coated with the diamond layer **52** without being subjected to the process illustrated in FIG. **13**C.

On the other hand, the cylindrical geometrical protrusions **28***b* shown in FIGS. **9**A and **9**B can be more effectively obtained by molding process, in which a substrate already being integrally formed with the cylindrical geometrical protrusions **28***b* is obtained by molding. The cylindrical geometrical protrusions **28***b* of the substrate is then subjected to a fine grinding process, directly followed by chemical vapor deposition process to be coated with a diamond layer. Similarly, a substrate having the rectangular geometrical protrusions can also be obtained by molding process.

More, the ditches and grooves of the present invention having an V cross-sectional shape can be realized by utilizing a diamond wheel having a rectangular end and by turning the substrate to be processed 45 degrees from its horizontal position.

A conditioner provided by the present invention exhibits an exceptional cutting ability and while its anti-wear and anti-corrosive properties being close to diamond renders the conditioner to have a prolonged lifetime usage. The geometrical protrusions of the cutting portion function as cutting blades and allows the conditioner to make point and surface contacts with the polishing pads in addition to its primary function of making a line contact. The diamond layer formed on the cutting surface provides the conditioner with exceptionally rigid and brittle properties. Specifically, the diamond layer strengthens the structural integrity of the cutting surface to decrease the wearing of the sharp edges of the cutting blades from polishing particles such as alumina, silica, and ceria from slurry. Further, by having the diamond layer coated on the cutting surface, the detachments of diamond particles from the cutting surface prevalent in the conventional conditioners can be eliminated, and metal ion contamination of the wafer circuits caused by corroded bonding metals from the surface of the conventional conditioners in metal CMP process can be prevented. Additionally, the diamond layer which has a thin and uniformed thickness provides consistent cutting performance while simultaneously increasing the grinding ability of the conditioner. More, the ditches and grooves having an U or V cross-sectional shapes further enhance the cutting efficiency of the conditioner by effectively draining residue particles from the cutting surface.

Hence, the conditioner provided by the present invention make it possible to achieve and control a desired cutting performance and provides an advantage of accomplishing a highly effective conditioning without the presence of high pressure. As a result, a polishing pad having an uniformly conditioned surface can be obtained to decrease the occurrences of imparting micro-scratches on the wafer surfaces, thus the productivity of semiconductor wafers can be increased while the production cost is reduced by an extended life of the polishing pads conditioned by the conditioner of the present invention.

A method for manufacturing a conditioner according to the present invention is relatively simple and has a distinctive advantage of not being confined or limited in manufacturing conditioners having cutting portions of various shapes and sizes. In view of different degrees of surface roughness of polishing pads required to polish wafer circuits and wafers made from various types of materials, the method provided by the present invention enables the manufacturing of conditioners appropriate for the polishing pads having different degrees of surface roughness by adjusting and controlling the size of geometrical protrusions, the distance between the ditches, the distance between grooves, and the thickness of the diamond layer. Hence, the method for manufacturing a conditioner for polishing pad according to the present invention is much more flexible and adaptive than the conventional electro-deposition and braze methods.

While the present invention has been particularly shown and described with reference to particular embodiments thereof, it is understood that the present invention should not be limited to this preferred embodiment, but various changes and modifications can be made by one skilled in the art within the spirit and scope of the invention as hereinafter claimed.

What is claimed is:

1. A method for manufacturing a conditioner for polishing pad, comprising the steps of:

a) making a substrate having a plurality of geometrical protrusions of a uniform height on at least one of its sides, a top surface of each of the geometrical protrusions defining a substantially flat surface, the geometrical protrusions being made of a material other than diamond; and

b) coating a diamond layer of a uniformed thickness substantially on a whole surface of the side of the substrate having the geometrical protrusions,

wherein a top of each of the geometrical protrusions defines a plurality of smaller geometrical protrusions of uniform height.

2. A method for manufacturing a conditioner for polishing pad as claimed in claim **1**, wherein the geometrical protrusions are formed on (a) a surface of at least one side of a substrate having a shape of a disk or a plate having multiple corners, (b) a surface of a ring portion being raised above an inner portion of a substrate having a cup shape, (c) a surface of at least one side of a substrate having a shape of doughnut with flat upper and lower surfaces, or (d) surfaces of segmented portions formed on the ring portion of the substrate having a cup shape or on surfaces of segmented portions formed on one of the sides of the doughnut shape substrate.

3. A method for manufacturing a conditioner for polishing pad as claimed in claim **1**, wherein the geometrical protrusions have a shape of rectangle and are arranged in a crossed-strip pattern.

4. A method for manufacturing a conditioner for polishing pad, comprising the steps of:

a) making a substrate having a plurality of geometrical protrusions of a uniform height on at least one of its sides, a top surface of each of the geometrical protrusions defining a substantially flat surface, the geometrical protrusions being made of a material other than diamond; and

b) coating a diamond layer of a uniformed thickness substantially on a whole surface of the side of the substrate having the geometrical protrusions, wherein step a) further comprises the step of forming a plurality of grooves in predetermined crossing directions to form a plurality of smaller geometrical protrusions in an uniform height on surfaces of the geometrical protrusions.

5. A method for manufacturing a conditioner for polishing pad as claimed in claim **1**, wherein step a) is accomplished by molding process in which a predetermined molding composition is injected and cooled in a mold having the shape of a substrate with geometrical protrusions.

6. A method for manufacturing a conditioner for polishing pad as claimed in claim **1**, wherein the substrate is made from ceramic or cemented carbide materials.

7. A method for manufacturing a conditioner for polishing pad as claimed in claim **1**, wherein the method further comprises the step of attaching a body portion to the substrate at a side opposite to the side formed with geometrical protrusions for linking the conditioner to conditioning device.

8. A method for manufacturing a conditioner for polishing pad as claimed in claim **1**, wherein the diamond layer to be coated on the substrate is formed by utilizing chemical vapor deposition (CVD).

9. A method for manufacturing a conditioner for polishing pad as claimed in claim **8**, further comprising a step of performing a pre-process for making diamond seeds on a skin of the substrate prior to the chemical vapor deposition (CVD).

10. A method for manufacturing a conditioner for polishing pad as claimed in claim **1**, wherein a top of each of the geometrical protrusions defines a flat surface.

11. A method for manufacturing a conditioner for polishing pad as claimed in claim **10**, wherein the geometrical protrusions are formed by machining crossed-strips of ditches on the top of the substrate.

12. A method for manufacturing a conditioner for polishing pad as claimed in claim **1**, wherein the geometrical protrusions are formed by machining crossed-strips of ditches on the substrate of which surface is flat and the smaller geometrical protrusions are formed by machining a plurality of grooves in predetermined crossing directions.

13. A method for manufacturing a conditioner for polishing pad as claimed in claim **11**, wherein the machining is performed by utilizing a diamond wheel machining apparatus and/or a laser beam machining apparatus.

14. A method for manufacturing a conditioner for polishing pad as claimed in claim **12**, wherein the machining is performed by utilizing a diamond wheel machining apparatus and/or a laser beam machining apparatus.

15. A method for manufacturing a conditioner for polishing pad as claimed in claim **13**, wherein the method further comprises the step of subjecting the substrate to fine grinding and lapping processes to obtain an uniform surface on at least one side of the substrate and to obtain substantially parallel substrate surfaces prior to implementing step a).

16. A method for manufacturing a conditioner for polishing pad as claimed in claim **14**, wherein the method further comprises the step of subjecting the substrate to fine grinding and lapping processes to obtain an uniform surface on at least one side of the substrate and to obtain substantially parallel substrate surfaces prior to implementing step a).

17. A method for manufacturing a conditioner for polishing pad as claimed in claim **1**, wherein each of the smaller geometrical protrusions is in pyramid or rectangular shape.

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